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Operating Manual for the 60cm Semiautogenous Grinding (SAG) Mill at the University of British Columbia (UBC)

by

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Abstract

The instructions needed to operate the 60cm semiautogenous grinding (SAG) mill at the University of British Columbia (UBC) are given. The mill is designed for continuous wet operation in closed circuit with a vibrating screen. The circuit is extensively instrumented with sensors for mill speed, mill torque, mill weight, various flows and alarm states. The circuit uses specially designed mass flowmetering systems for the fresh feed and recycle streams. The fresh feed system is able to measure small (0-2.5 Kg/min) mass flow rates of the coarse (-30 mm) fresh feed material. Control is by an Action™ BC20 computer running FIX ACE™ process control software. The system provides automatic startup, shut down, alarming, control, data logging, trending and the man machine interface to the circuit. Fisher™ digital controllers provide an alternative means of control. Various control strategies are possible. The present strategy is to control the mill load by cascading the deviation from load set point as the set point to the fresh feed rate program.

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Purpose

The main purpose of the operators manual is to provide enough information for the new operator to run the 60cm semiautogenous grinding (SAG) circuit at the University of British Columbia (UBC) under normal conditions. This includes preparing the mill feed; starting, running, sampling and stopping the circuit; analyzing the samples; and using the historical data collected by the computer. The circuit is fully described in the thesis Implementation of a Flexible System for Control and Measurement of a Laboratory Scale Continuous Semiautogenous (SAG) Mill at the University of British Columbia (UBC)[1]. Technical information on the circuit components is found in Technical Data for Equipment Used in the 60cm Semiautogenous Grinding (SAG) Mill at the University of British Columbia (UBC) and the other manuals stored under the computer monitor.

Introduction

When a milling project is amenable to SAG, it has become the preferred comminution method. There are many examples of successful SAG milling in British Colombia among them are: Afton, Highland Valley Copper, Island Copper, and Similco. SAG eliminates secondary and tertiary crushing, which lower the capital costs of the project. Operating costs can also be lowered by using SAG[2].

The 60cm circuit was made to study four areas of SAG: the feasibility of scale up, to assess the influence of design variables, to develop mathematical models, and to evaluate the effects of alternative control strategies on circuit performance. SAG is usually studied by using pilot scale mills. Scale up testing is also done using pilot plants. Existing pilot scale testing facilities generally use mills 1.5 to 2.0m in diameter with lengths from 0.6 to 5m. They require 10 to 50 metric tons of ore for each test. Many hours are required to perform a test. And skilled personnel are required to conduct and interpret the test work. The cost of a test program using these mills can be prohibitive.

The 60cm circuit requires less material, and shortens the duration of the test ;therefore, it allows the detailed investigation of many more aspects of SAG milling as well as provides a means of SAG mill scale up for smaller lower tonnage properties. A test can be completed within a four hour period, although density determinations and size analyses (including the mill contents) at key points in the circuit may take an additional day. Declan Corrigan[3],[4] at UBC has proposed a qualitative correlation between the 60cm mill and full size SAG mills. Also, MacPherson[5] has successfully used a 45cm diameter dry Aerofall SAG mill for scale up of large mills.

Description of Circuit[6]

Figure 1 is a simplified material flow and instrumentation diagram of the circuit, which shows the circuit's equipment, sensors and material flow streams. The following sections describe the circuit.

Equipment, sensors, and actuators

Referring to Figure 1, the fresh feed system supplies the mill with fresh feed at the rate requested by the mill weight controller. It consists of an Eriez™ 40A vibrating chute feeder with a 30 N vibrator, Eriez™ VFT/115 vibration intensity control box; and, a feed bin with a solenoid to open the bin door and load cell to measure the amount of ore in the bin. The fresh feed mass flowmeter is described in the next section.

Water is fed to the mill via a 1.25 cm PVC line. It's flow is measured by a differential pressure cell and is controlled by a pneumatically actuated one quarter inch control valve. The flow rate is in direct ratio to the total solids fed, ie fresh feed and screen oversize.

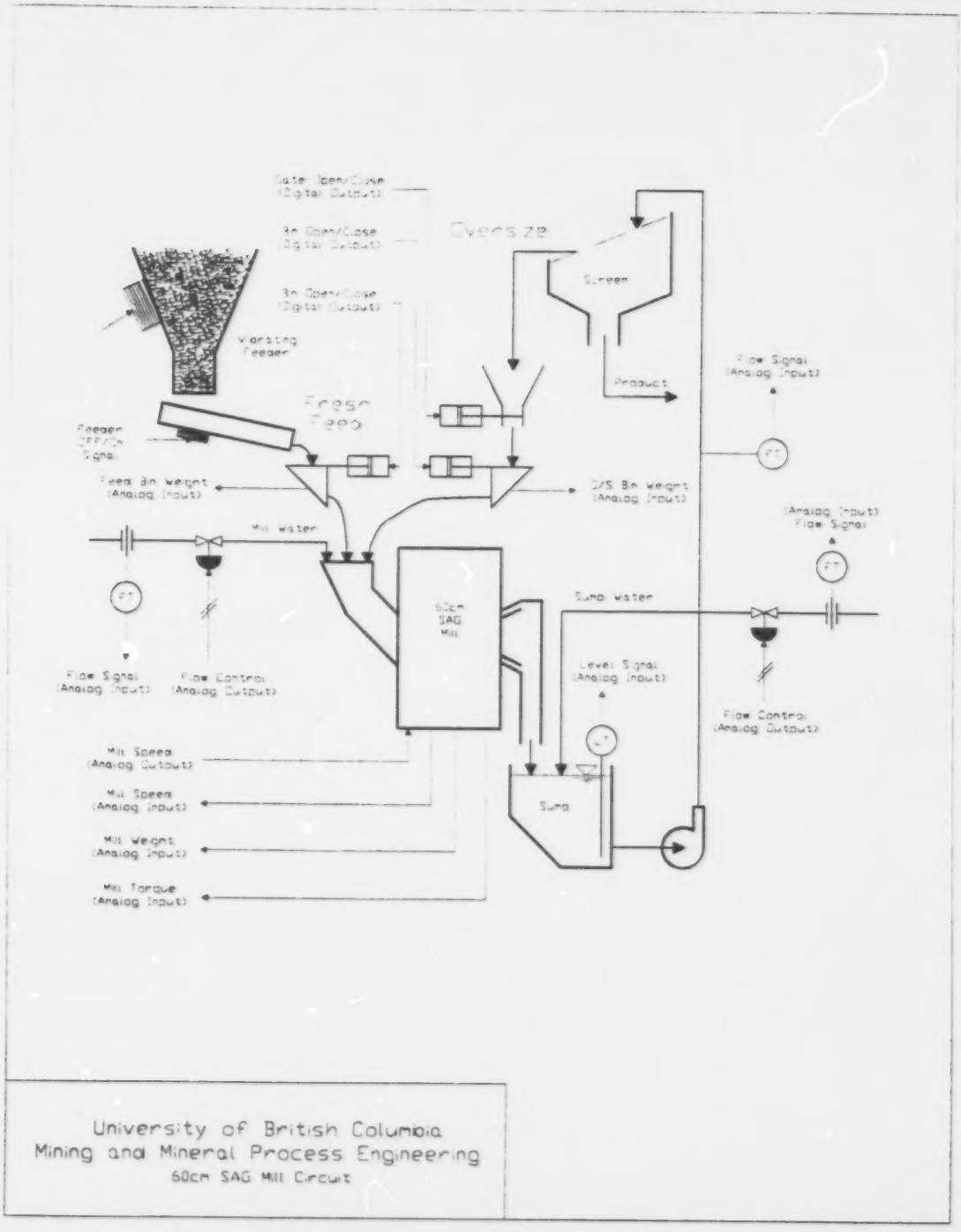

Figure 1. Simplified Flowsheet Showing the Equipment, Instrumentation, and Ore and Water Flows in the 60cm SAG Mill Circuit at the University of British Columbia.

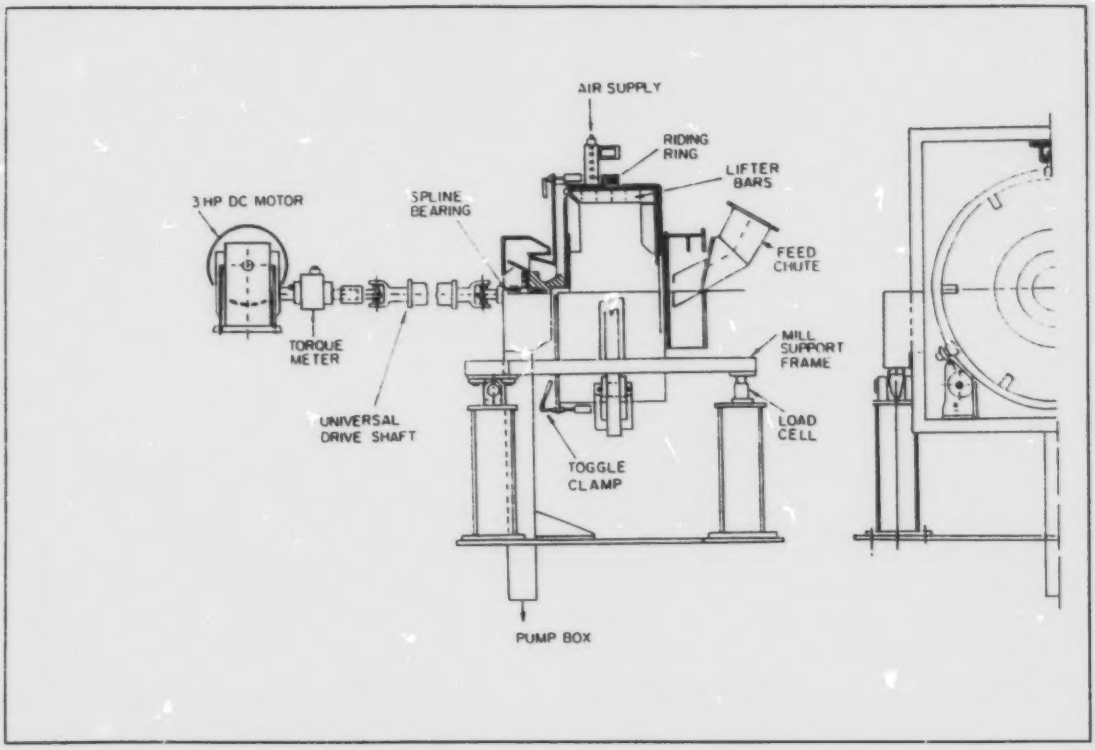

Figure 2. Sectional View of the 60cm SAG Mill Used in the SAG Mill Circuit at the University of British Columbia.

The 60 cm mill was designed and built by Dominion Engineering Works Ltd[7]. Figure 2 is a sectional view which shows important details of construction. The mill is 25cm long by 60cm in diameter, with 1cm slots in the discharge grate. The mill is driven by a 3hp variable speed DC motor. Mill speed range is between 0 and 58rpm, critical speed is 54rpm. The mill is fully controlled and instrumented with sensors for mill torque, mill weight, and mill speed. The mill speed is manipulated by a 4 to 20 mA signal to a Ratiotrol™ motor actuator. Mill product discharges to a 60cm deep x 60cm long x 40cm wide urathane lined steel sump box. Sump level is measured by a capacitance probe. Sump water is fed by a 3.2cm PVC pipe. The flow is measured by a differential pressure cell and manipulated by a pneumatically actuated one inch control valve. The slurry is fed to the vibrating screen by means of a 6.35 cm vac-seal centrifugal pump whose speed is set manually by adjusting a variable diameter pulley. The pump discharge rate is measured by a Foxboro™ magnetic flowmeter.

Pump discharge is sized on a 60cm by 90cm Universal™ vibrating screen which has 0.625cm square openings and is angled at 25° to the horizontal. Screen efficiency is very high. Undersize is fed to a drum thickener, while oversize is returned to the mill via a specially designed mass flowmeter. The flowmeter bin has a load cell to measure the mass of oversize, and an air piston assembly to open the bin door. A gate, controlled by a solenoid, is used to manipulate the flow of oversize to the oversize bin.

Fresh feed mass flowmeter

The fresh feed mass flowmeter was designed for flows from 0 to 2.4Kg/min. The meter simulates the continuous flow of solids to the mill by adding small batches of ore at frequent intervals. Figure 3 shows components of the fresh feed assembly. The apparatus is controlled by a computer program (see appendix A) that also calculates the batch weight setpoint. When the batch time starts the bin is empty, the bin door is closed and the vibrating feeder is off. First, the vibrating feeder is turned on until it fills the weighing bin to the weight target. The bin weight is measured by a load cell. When the bin weight is reached the vibrating feeder is turned off and the system waits to allow the load cell to settle. Then a final gross bin weight is taken. Next, an air valve (solenoid) opens the bin door discharging the ore into the mill. The door closes, the system waits to allow the load cell to settle, and the empty bin weight is measured. The computer program calculates the mass added to the mill and the flow rate to the mill. To maintain the desired flow rate, the program compensates for overweight or underweight batches by subtracting or adding weight, respectively, to the batch weight target used in the next cycle. The system then waits until the beginning of the next batch time, when the cycle is repeated.

Oversize mass flowmeter

The screen oversize mass flowmeter assembly is shown in Figure 4. The meter simulates the continuous flow of solids to the mill by adding small batches of oversize at frequent intervals. The apparatus is controlled by a computer program (see appendix A). The bin weight target is input by the user at the beginning of the mill startup, it is normally set at 100g. When the operating cycle starts the bin is empty, the bin door is closed and the oversize sliding gate is open. Screen oversize falls into the bin until it reaches the weight target. Then the gate is closed by means of an air cylinder (solenoid). When the gate is closed the system waits to allow the load cell to settle and a final gross bin weight is taken. Next, the bin gate is opened by the solenoid air piston assembly to dispense the oversize into the mill. The door is closed, the system waits to allow the load cell to settle, and the empty bin weight is measured. At this point the sliding gate is opened and the cycle is repeated. The computer program calculates the mass added to the mill and the average flow rate of oversize to the mill.

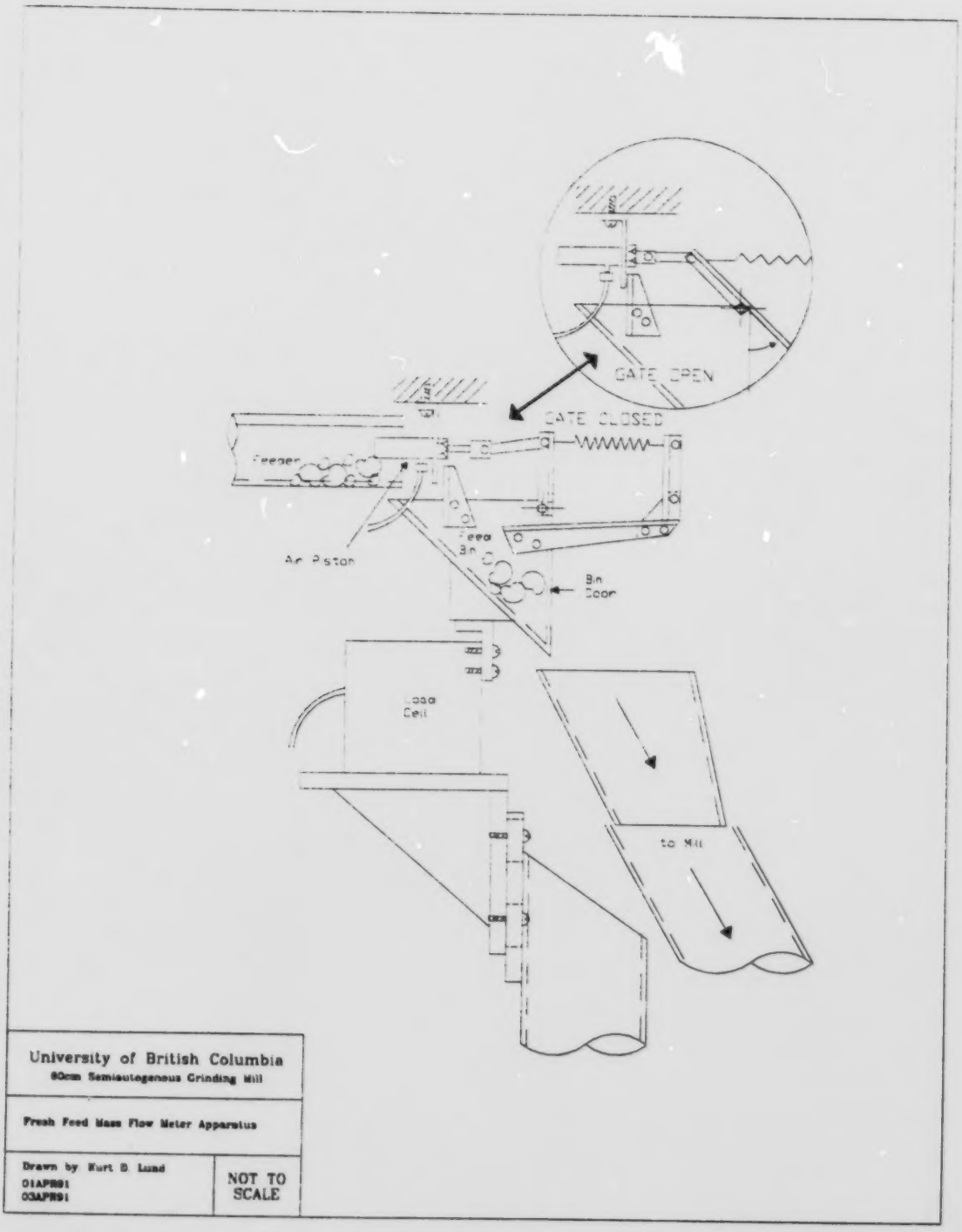

Figure 3. Fresh Feed Flowmeter Apparatus for the 60cm SAG Mill Circuit at the University of British Columbia.

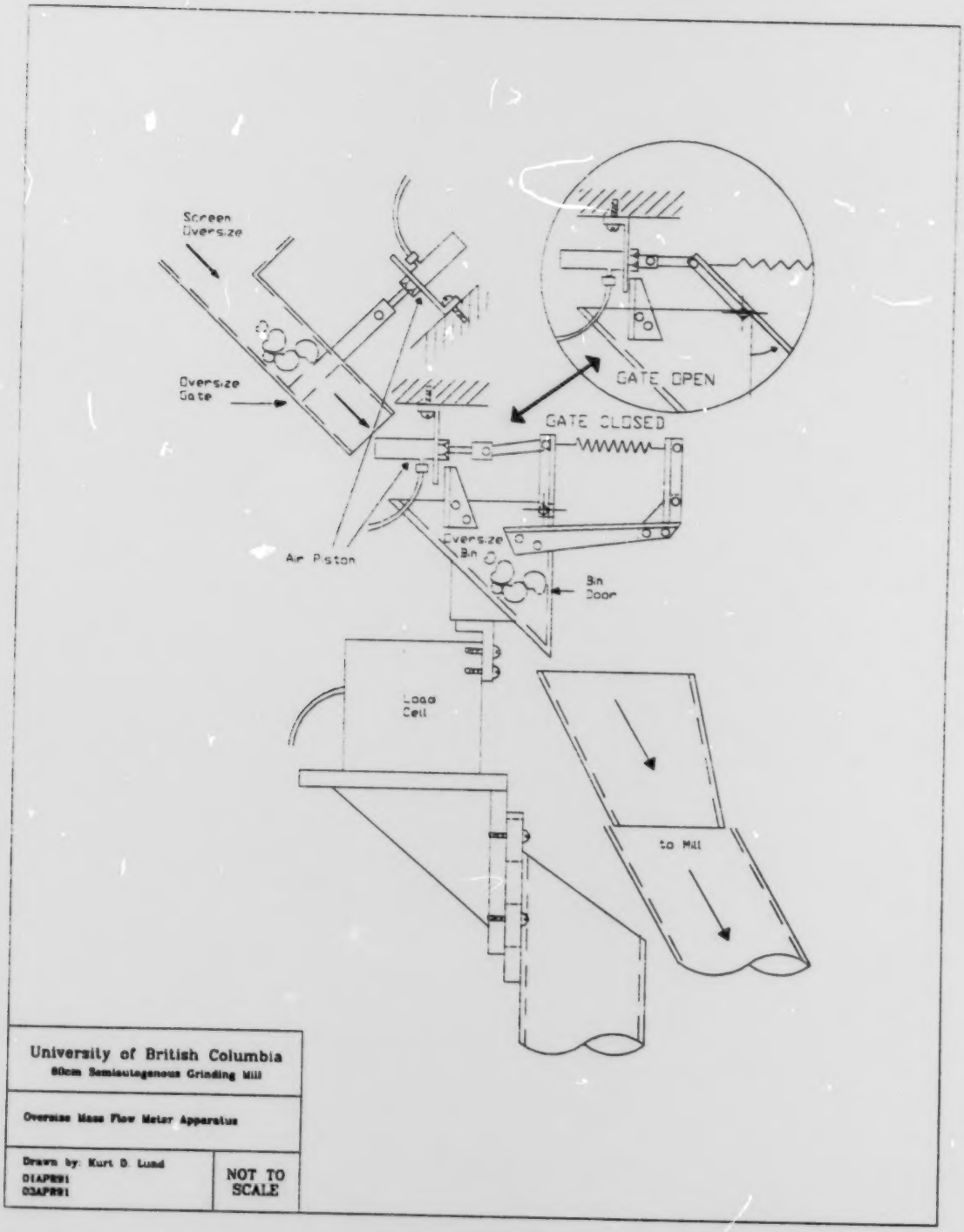

Figure 4. Oversize Flowmeter Apparatus for the 60cm SAG Mill Circuit at the University of British Columbia.

Control of the Circuit

The 60cm circuit is normally controlled by an ACTION™ BC20 AT computer using FIX™ control software. The circuit provides automatic startup and shutdown, regulatory control, the man machine interface, historical data acquisition and logging, and alarm handling. The FIX™ also interfaces with the C programs for the fresh feed and oversize control and measurement systems. FISHER™ DPR900 single loop controllers are used to backup or supplement computer control of the circuit when needed. These two systems are described below.

Single loop controllers

The FISHER™ DPR900 integral controller is a single loop, user configured, digital proportional integral derivative (PID) controller. The display shows the process value (PV), setpoint (SP), and output signals (OS). All normal controller functions and many advanced features, like autotuning, square root, and gain scheduling, are available through user configurable function codes. They are fully described in Technical Data for Equipment Used in the 60cm Semiautogenous Grinding (SAG) Mill at the University of British Columbia (UBC) stored under the computer monitor at the SAG mill.

The controllers are used to supplement or replace computer control of the mill circuit and are turned 'on and off' by the user from the FIX™ control system. In the current control system they are not normally used for control. They are initially configured in set point follower mode; ie. they pass on their setpoint signal as their output signal. The Fisher™ controllers receive the output signal from the controllers in FIX™ as their setpoint signal. If the Fisher™ controllers are needed they can, of course, be changed to local mode and used as normal PID controllers by the user. Only the sump level control can be operated without the computer.

Figures 5, 6, and 7 show the control loops containing the four single loop controllers. One is used as a ratio controller for the mill water. Two are used, in proportional integral (PI) mode, in a cascade loop to control the sump level, and one PI controller is used for the mill speed. The sensors used in these control loops are described in Technical Data for Equipment Used in the 60cm Semiautogenous Grinding (SAG) Mill at the University of British Columbia (UBC) stored under the computer monitor at the SAG mill. The following sections describe how they are used when they are switched on from the CONTROL Overview display using the F6 key (see Figure 14, on page 20).

Mill Speed:

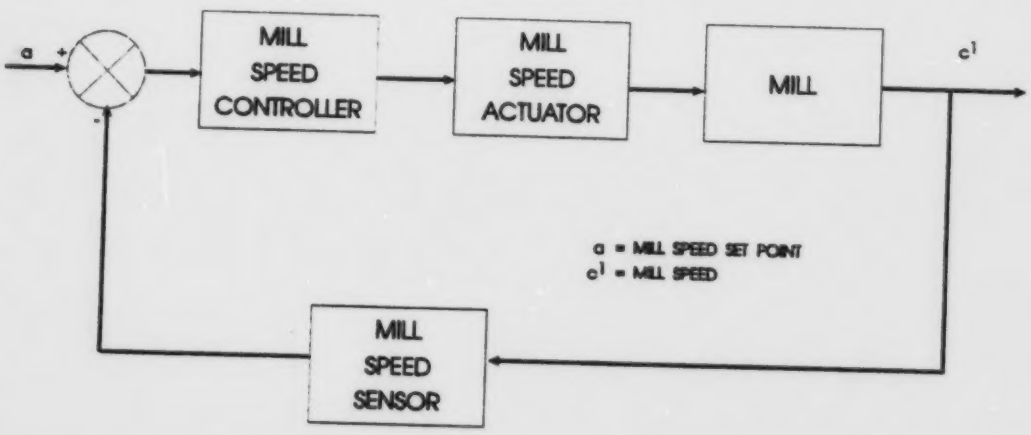

Figure 5. Mill Speed Control Loop for the 60cm SAG Mill Circuit at the University of British Columbia.

Figure 5 shows the components of the mill speed loop. The Fisher™ DPR900 controller (SIC-MS, speed indicating controller for the mill speed) uses PI control. The controller was tuned using trial and error. The setpoint for the SIC-MS is provided by the FIX™ computer control system. The user inputs the desired mill speed to the computer during the circuit startup procedure and the computer uses it in the FIX™ or passes the setpoint on to the FISHER™ speed controller. The mill speed is measured using an AMETEK™ model 1020 encoder (pulse generator), which makes 120 pulses each mill revolution. The computer input/output equipment converts the signal to its percent of critical speed and sends it to the speed controller as a 4-20mA signal. The mill speed controller output is sent to the Ratiotrol™ mill motor actuator. The 4-20mA output signal varies the mill speed between 0 and 58rpm (0 to 108% crit speed).

Mill Water:

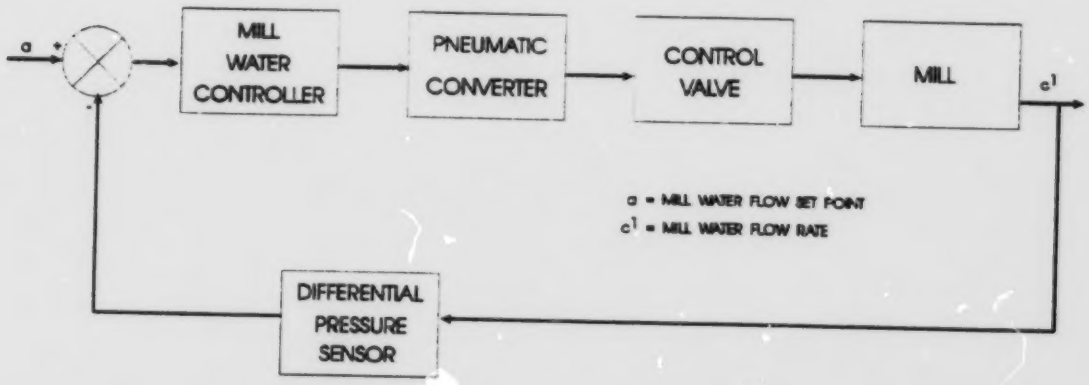

Figure 6. Mill Water Control Loop for the 60cm SAG Mill Circuit at the University of British Columbia.

Figure 6 shows a block diagram of the mill water flow control loop. The FISHER™ DPR900 controller (FIC-MW, flow indicating controller for the mill water flow rate) uses PI control. The controller was tuned using the trial and error method. The mill water ratio is provided by the user during the circuit startup. It is used to calculate the mill water flow rate set point by the following formula:

$$MW_{sp} = \frac{(M_f + M_o)MW_r}{1000} \qquad \text{(eq 1)}$$

where, MW_{sp} = FIC-MW setpoint, lpm
M_f = mass flow of fresh feed, g/min
M_o = mass flow of screen oversize, g/min
MW_r = desired ratio of water flow to total solids flow
1000 = conversion between g/min solids flow and l/min water flow

The mill water flow rate is measured using a Foxboro™ E13M series differential pressure (D/P) transmitter. The square root of this signal is proportional to the Mill water flow rate. Calculation of the square root of the D/P signal is done in the Fisher™ DPR900 controller by a function code. The mill water controller output is converted to a pneumatic signal using a Foxboro™ E69F field mounted current to pneumatic signal converter. The pneumatic signal actuates a, Badger™, one quarter inch air to open control valve.

Sump Level:

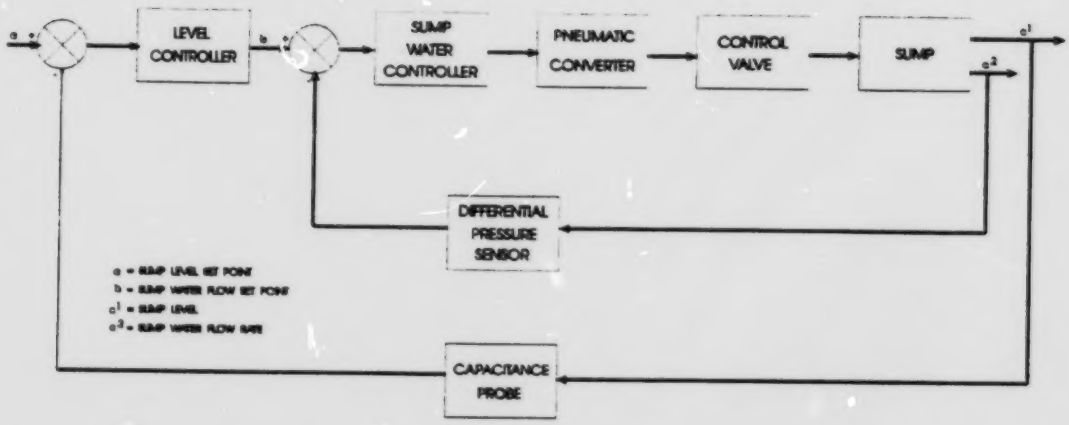

Figure 7. Sump Level Cascade Control Loop for the 60cm SAG Mill Circuit at the University of British Columbia.

Figure 7 shows the components of the sump level cascade loop. Two Fisher™ DPR900 controllers are used for level; master loop, level control (LIC-S, level indicating controller for the sump); and slave loop, sump water control (FIC-SW, flow indicating controller for the sump water). Both of the controllers use PI control. The controllers were tuned using trial and error. The process value (PV) for the LIC-S is provided by a Great Lakes Instruments™ 690L level sensor, which is a capacitance probe. The setpoint is provided by the user through the FIX™ computer control system. The output of the sump level controller is cascaded to the sump water controller as its setpoint.

The PV for the FIC-S is the sump water flow rate. It is measured using a Foxboro™ E13M series differential pressure (D/P) transmitter and a 0.15cm orifice plate. The square root of this signal is proportional to the sump water flow rate. Calculating the square root of the PV (process value) is done by one of the functions codes available in the Fisher™ DPR900 controller. The sump water controller output is converted to a pneumatic signal using a Foxboro™ E69F field mounted current to pneumatic signal converter. The pneumatic signal actuates a Robert Shaw™ one inch air to open control valve.

Computer control

The control computer is an ACTION™ AT industrial computer. It has a 12MHz clock and four megabytes of RAM. It has three disks; two floppy disks: 1) a 5-1/4" 360KB, and 2) a 3-1/2" 720KB and a 50MB hard disk. It uses the FIX ACE™ control software and the fresh feed and oversize computer programs (see appendix A) to provide regulatory control of the circuit. The control software also provides alarming, man machine interface, automatic startup and shut down, data collection and report generation. The computer also has A Real Time Interface Coprocessor (ARTIC™) card. The card gives the system a 0.1sec scan time. This short scan time is needed for the oversize and fresh feed measurement and control systems.

Input and output (I/O) between the circuit sensors and the computer is via two ACTION IO PAKs™; one for analog signals, and one for digital signals. They use Optomux™ protocol to communicate with the computer via a RS-232C serial link at 9600 baud. The two IO PAKs™ are connected in parallel by a RS-422 connection(multi-drop mode). Manufacturers information on the computer, ARTIC™ card, IO PAKs™ and the FIX ACE™ is in the manuals stored under the computer monitor at the SAG mill.

man/machine interface

The man machine interface is provided by displays and menus viewed on the computer monitor. During the normal running of the mill only the displays are needed. They provide easy detailed access to information and control of the circuit. All the displays and key macros are given in Appendix B. The circuit is controlled and data displayed by links from the database to the displays. The links are selected and data input from the keyboard.

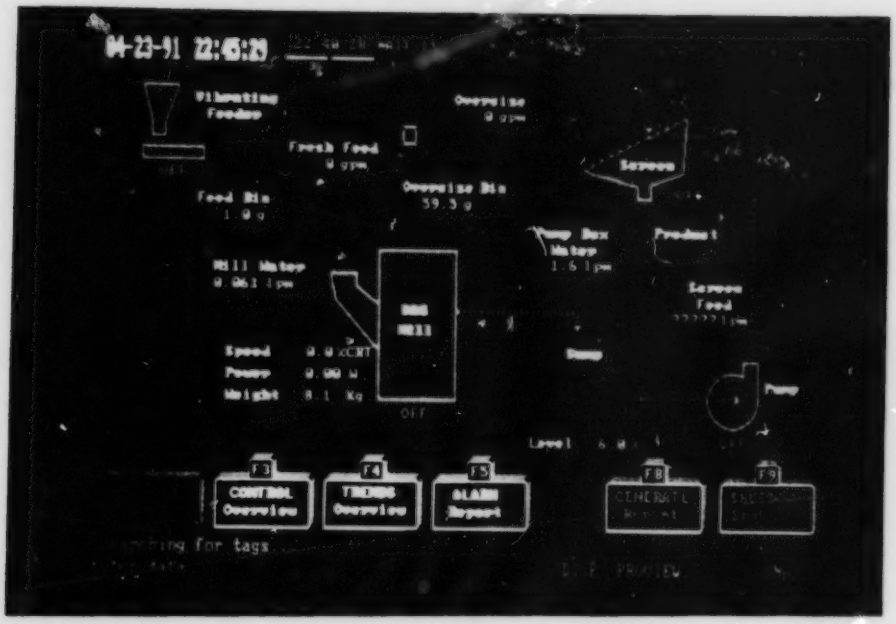

Figure 8. Process Overview Display for the 60cm SAG Mill Circuit at the University of British Columbia.

Figure 8 shows the process overview display (PROVIEW), which is similar to a real time flowsheet. Along the bottom are the <F keys> that move to other displays and initiate control actions. Help is always available by hitting the <F1> key. In the body of the display the flows and weights are real time values. Subpictures and links animate the display. The current time and date are in the upper left corner. To the right of the time is the alarm window. The small bars along the top flash (one for each alarm) when an alarm is active. In addition the last alarm message is displayed in the small window in the upper right of the display. The other displays are used for other aspects of control ie., starting, stopping, tuning the regulatory control loops, trending of flow rates, power, etc. The procedure(s) for starting, stopping and operating the circuit using these displays is given later in this manual.

regulatory control

When the system starts regulatory control, by default, is by the FIX ACE™ control software. The control actions and sensors are the same whether the control is done in the computer or by the single loop Fisher™ controllers. There are four control loops in the system three of them have already been described in the previous section (Single loop controllers). They are: mill speed, mill water, and sump level. The fourth loop, mill weight, is described below.

Mill Weight:

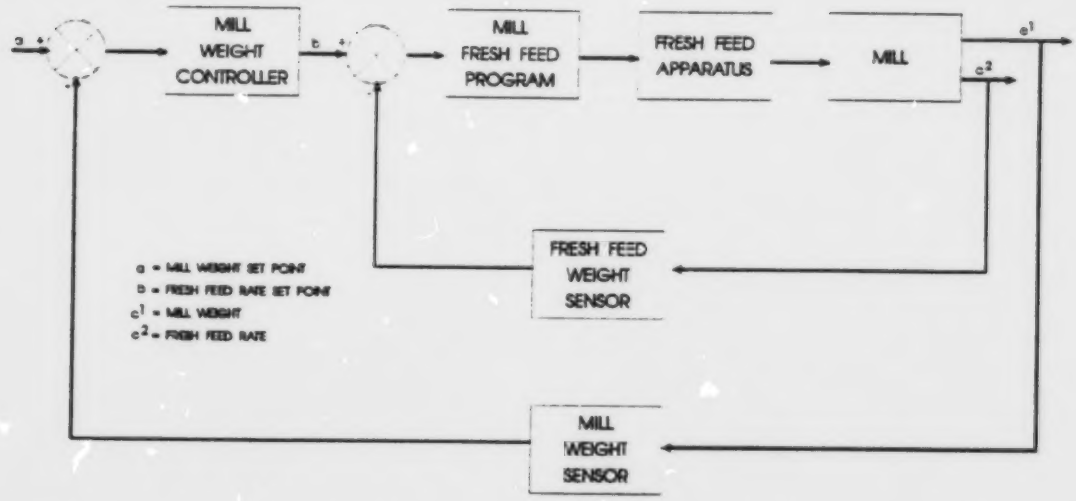

Figure 9. Mill Weight 'Cascade' Control Loop for the 60cm SAG Mill Circuit at the University of British Columbia.

Figure 9 shows the components of the mill weight 'cascade' loop. The master loop is the mill weight controller (PI-WM, proportional controller for the mill weight). The output of this loop is the needed fresh feed mass flow rate, which is cascaded to the fresh feed control program. The PV for the PI-WM is provided by a BLH Electronics™ load beam transducer weight sensor, which is a strain sensor. It's setpoint is provided by the user through the FIX ACE™ computer control system. The mill weight controller was tuned using trial and error.

The PV for the fresh feed program is the actual weight of ore added to the mill. It is measured by the feed bin load cell and calculated by the program. The program adjusts the weight of ore added to the mill in each bin to achieve the desired flow rate, provided by the mill weight controller. The actions of the fresh feed system are described above (Fresh feed mass flowmeter). The program is described in Appendix A.

Table 1. Historical Data Collected by the FIX ACE™ Control System for the 60cm SAG Mill Circuit at the University of British Columbia.

Tag Name	Nomenclature	Trend Group
AID-FF	Fresh feed rate, gpm	feed group
AID-OS	Oversize feed rate, gpm	feed group
AIF-LS	Sump level, %	sump group
AIF-MW	Mill water flow rate, lpm	feed group, sump group
AIF-SF	Screen feed, lpm	sump group
AIF-SW	Sump water, lpm	sump group
AIF-WM	Mill weight, Kg	mill group
CA-JM	Mill power, watts	mill group
CA-TF	Total feed to mill, gpm	feed group
RB-MS	Mill speed, %critical	mill group

data collection, and reporting

Data collection and reporting is done by the FIX ACE™ control software. Table 1 shows the data that is collected. They are sampled every six seconds and saved as one minute averages. The data collection is done automatically and starts when the system is started. The data can be viewed using the historical data display package in the control software. Hard copy reports and trends are available by using the software. Data can be exported as an ASCII file or in Lotus® PRN format. A summary report is generated at the end of the run by pressing the <F8> key on the process overview display (PROVIEW). An example of the report is in Appendix B.

SAG Mill Feed Preparation

The proper preparation of the mill feed is essential for the reliability and reproducibility of each test. The following procedure will ensure the SAG mill feed remains representative of the ore sample used in the test.

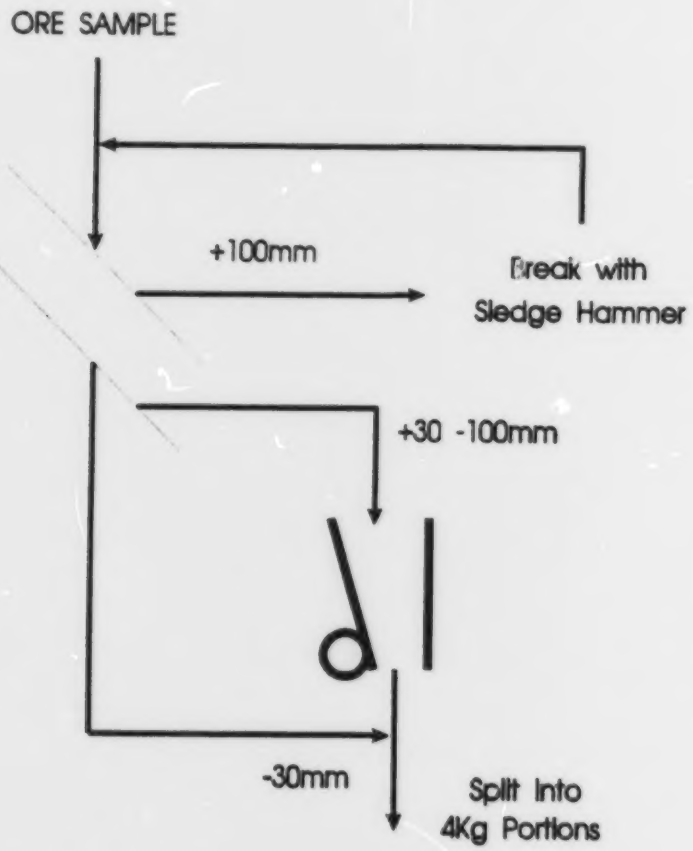

Figure 10. Fresh Feed Preparation Flowsheet for the 60cm SAG Mill Circuit at the University of British Columbia.

Apparatus:

- Jaw crusher, in crushing room
- Pallet jack, in crusher room
- Large Jones riffler, in crushing room
- Electric fork lift, main lab room
- Eye and ear protection
- Square blade shovel
- Scoop
- Plastic bin(s)
- Pan(s)

Material:

- Ore sample, 50Kg per test

Procedure:
1. Turn on/off the following equipment.
· Turn on the dust collection system

2. Adjust the crusher discharge to 30mm. Refer to figure 10. Screen the ore sample. Crush material larger than 30mm with the jaw crusher. After all the material is less than 30mm cone and quarter the ore, then recombine the quarters into a pile. Repeat until the ore is well mixed.

3. Split the feed into four Kg portions with the Jones riffler or another suitable method and put the portions into pans. Save one pan for feed screen analysis. The ore is added to the feed bin in small amounts to prevent segregation in the hopper. Put the pans into large grey plastic bin(s) and use the electric fork lift to put them on the orange platform. During the mill startup, filling the mill, add two to four pans at a time to the feeder hopper. When the mill is at steady state add them one at a time.

4. Turn on/off the following equipment:
· Turn off the dust collection system
· Clean up

Running a Test

The following procedures give the steps needed to start the circuit, run the mill until it reaches steady state, sample the circuit, and shut down the system. Automatic (historical) data collection and the computer generated report are also discussed.

Pre-Operation Check List and Startup

The following procedure provides the steps necessary to start the SAG mill circuit in a safe and consistent manner. The control system allows a automatic startup with very little operator input, the normal way the circuit is operated, or manual control and startup of the circuit.

Apparatus:
· Key to turn on the computer, found in room 310A
· Eye and ear protection
· Bucket(s)
· Scoop
· Plastic bin(s)
· Pan(s)

Material:
· Crushed ore sample, 50Kg per test, prepared by the method given in 'SAG Mill Feed Preparation' in the previous section.

Procedure:
1. Be alert, inspect the circuit as you go through the startup procedure. If there is any broken, missing or damaged equipment fix it immediately! Start by climbing the ladder to the orange mezzanine platform. Add two to four pans of crushed ore to the feeder hopper. Turn on the manual on/off switch at the feeder and make sure the hopper and tray vibration controls are set at 60 and 20 respectively. Next, turn on the manual on/off switch at the vibrating screen. Inspect the fresh feed and oversize apparatus. Make sure they can move freely.

Figure 11. Startup Parameter Display for the 60cm SAG Mill Circuit at the University of British Columbia.

Figure 12. Manual or Automatic Startup Display for the 60cm SAG Mill Circuit at the University of British Columbia.

2. Go down the ladder and turn on the manual on/off switch at the pump motor. Ensure the drain plug, in the pipe tee between the centrifugal pump inlet and the sump discharge, is in place and snug.

3. Go to the mill motor and turn off the manual on/off switch at the mill motor actuator (Ratiotrol™ box). Next, attach the mill door and clamp it shut. Position the yellow discharge pipe at the mill discharge and attach its base to the sump with the C clamp (stored on the plate beneath the mill). Then, put the 19mm sieve in the holder beneath the discharge pipe. Make sure the mill turns freely and is not touching the yellow discharge pipe. Attach the shaft between the torque meter and the mill (stored under the mill motor gear reducer). The screws and Allen wrenches are in the blue tool box, which is stored under the mill motor gear reducer. Turn on the manual on/off switch at the mill motor actuator.

4. Turn on the water supply valve, located above your head and to the right when you are facing the counter. Next, turn on the compressed air supply valve, located to the left and above the far right (air panel box) panel box. Open the middle (power panel box) and switch on the 110VAC and 208VAC power circuit breakers. Clean up around the circuit.

5. Turn on the computer with the key and the monitor by opening the small front panel on the monitor and pushing the white on button. Make sure there is paper in the printer (the report needs four pages to print) and turn on the printer. The computer control program starts automatically when the computer is turned on. Figure 11 'startup parameter' screen (START) will be displayed first. Help is always available by hitting the <F1> key, it tells you the actions that are possible in the display you are viewing. Fill in the appropriate values and hit the <F2> key to move to the next display, . Figure 12 'manual or automatic startup' (R1) screen will replace the startup parameter screen. When you are ready to begin the run hit the <F8> key to initiate the automated mill startup.

6. If the user needs to manually start all or part of the circuit hit the <F9> key. This will bypass the automatic startup sequence and go directly to the process overview (PROVIEW) display. Use the help <F1> key to learn how to turn on/off motors, open the bins, etc. From the process overview display the <F3> key moves to the control overview display, it allows the user to access to the regulatory controllers used in the circuit. Again use the <F1> key to learn how to change from manual/automatic, change setpoints, etc.

7. In automatic startup figure 13 process overview (PROVIEW) display will replace the R1 screen when the <F8> key is pushed. At this point the circuit is under the control of the computer. The operator's main functions during this time are:

- Add the steel balls to the mill when prompted by the program
- Make sure there is always crushed ore in the fresh feed bin
- Make sure the fresh feed and oversize weighing bins do not jam
- Ensure that the sump discharge is not plugged by mill discharge solids

8. Ten minutes after the mill reaches it's operating speed the program prompts the user with a message in the upper right hand corner of the proview display to add the steel charge. The user has three minutes to accomplish this task. The steel is added at the 'Y' at the feed end of the mill.

9. During the mill filling stage add two to four pans of crushed ore to the feeder hopper each time the hopper is refilled. When the mill has filled add one pan at a time. Table 2 gives instructions on how to solve common problems including those caused by pebbles jamming the sump discharge and the fresh feed and the oversize bin gates. The automatic startup sequence ends when the mill reaches it's weight setpoint and the mill weight controller switches to automatic mode. The mill will continue to operate until the shut down sequence is started by hitting <F9>.

Operation to Achieve Steady State Conditions

The following section explains the operator's duties after the initial filling of the mill. The displays used during steady state operation are also discussed. And the procedure used to take samples around the circuit are given. Generating the summary report is also discussed.

Apparatus:
- Eye and ear protection
- Bucket(s)
- Scoop
- Plastic bin(s)
- Pan(s)
- Stopwatch

Procedure:

1. At the end of the startup procedure the circuit is under the control of the computer. The operator's main functions during this time are:
   - Make sure there is always crushed ore in the fresh feed bin, add one pan at a time
   - Make sure the fresh feed and oversize weighing bins do not jam
   - Ensure that the sump discharge is not plugged by mill discharge solids
   - Sampling the circuit
   - Decide when the circuit has reached steady state, by monitoring the process values
   - Generate the summary report, by hitting the <F8> key
   - Initiate the shut down sequence, by hitting the <F9> key

2. Table 2 gives instructions on how to solve common problems including those caused by pebbles jamming the sump discharge and the fresh feed and the oversize bin gates.

Table 2. Troubleshooting Guide for the 60cm SAG Mill Circuit at the University of British Columbia.

Problem	Recommended Solution
FEED BIN, pebble jam	Jog the bin door. In the "PROCESS Overview" screen the bin door can be opened and closed by hitting <alt><F> twice to toggle the link to the bin door. If this does not work do the following: a) in the fill-up phase it is not critical to measure feed rate so bypass the weighing bin by manually loading the pebble into the mill feed port b) during steady state operation manually place the pebble in feed bin, wait over 2s after fresh feed bin door has closed c) discard the pebble
FEED FUNNEL, pebble jam	Remove jam manually; place the pebble in the mill feed port.
OVERSIZE GATE, pebble jam	Jog the oversize gate. In the "PROCESS Overview" screen the oversize gate can be opened and closed by hitting <alt><G> twice to toggle the link to the oversize gate. If this fails, push the sliding gate downwards and then release it suddenly. Or remove the pebble and place it in the bin.

Table 2 (cont). Troubleshooting Guide for the 60cm SAG Mill Circuit at the University of British Columbia.

Problem	Recommended Solution
OVERSIZE BIN, pebble jam	Jog the oversize bin door. In the "PROCESS Overview" screen the oversize bin can be opened and closed by hitting <alt><O> twice to select the link to the oversize bin. If this fails, manually remove the pebble(s) and place them in the oversize bin, wait over 2s after oversize bin door has closed.
MILL FEED PORT pebble jam	Increase the mill water flow to flush the jam into the mill turn the mill water controller to manual and change the flow to it's maximum value. If this is not successful, push the material into mill with the steel rod stored against the front of the sump.
SUMP, pebble jam	The pump is jogged by the computer when the screen feed falls below 80lpm. Jog the pump manually , if needed, by turning the pump off, waiting a few seconds and the turning it back on. If this fails, use the plunger, stored by the sump, to try to free the blockage. To prevent a recurrence, increase the pump speed.
SUMP, pebble jam (cont)	If the jam blockage was not removed do the following: a) replace the 19mm sieve on the mill discharge pipe with the round pan beneath the mill motor gear reducer b) turn off the manual pump motor switch c) turn the sump water controller to manual and adjust the flow to zero d) remove the plug from the tee between the pump and sump e) drain and flush the sump and tee f) replace the tee, turn the controller back to manual, and when the sump has filled turn on the pump switch g) if the screen feed flow is **normal** (above 85lpm) replace the pan with the 19mm sieve, if the flow is **low or stopped** shut down the circuit and disassemble the piping as needed to free the blockage

3. The operator interacts with the computer control program through the display screens (Figures 11 to 17) and the keyboard. Help is available for each display by hitting <F1>. All the displays and macros are given in Appendix B. A general description of the man/machine interface is given above in the section 'man/machine interface'. Each of the four displays normally needed are discussed below.

Process Overview:

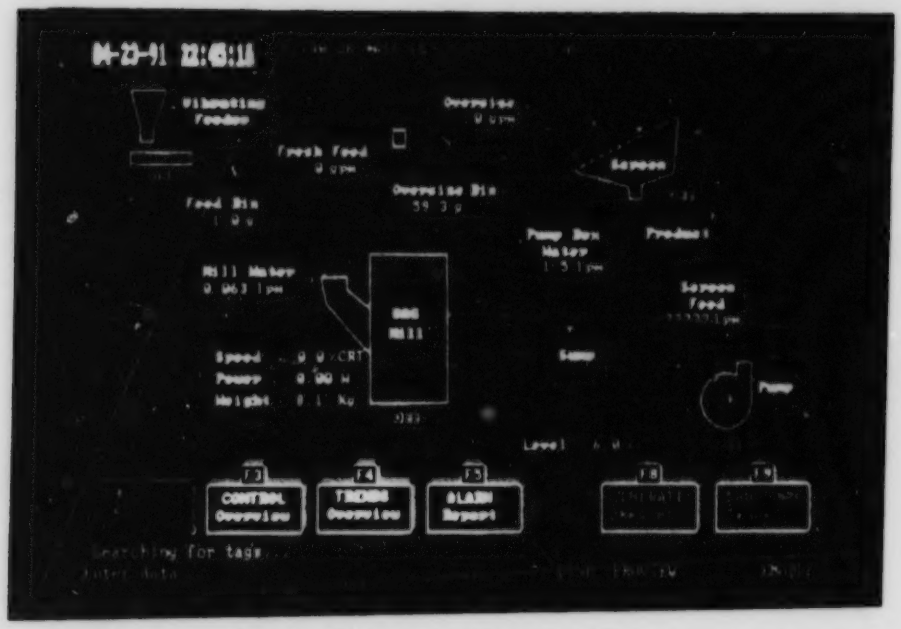

Figure 13. Process Overview Display for the 60cm SAG Mill Circuit at the University of British Columbia.

Figure 13 shows the process overview display (PROVIEW), which is similar to a real time flowsheet. Help is available in any display by hitting the <F1> key. In the upper left corner the date and time are shown. To the right of the time is the alarm window. The small bars along the top flash (one for each measured or calculated circuit parameter) when an alarm is active. In addition the last alarm message is displayed in the small window in the upper right of the display.

The circuit flowsheet shows the current calculated and measured real time values of weights, flows, etc. Subpictures and links animate the display. Key macros are used to override the computer's control of the equipment in the display, ie. motors, bins, and the oversize gate. The buttons across the bottom are key macros, they are used to move to other displays, generate the summary report, and shut down the circuit. The PROCESS Overview button is dimmed and has no <F key> to show it is the current display.

Control Overview:

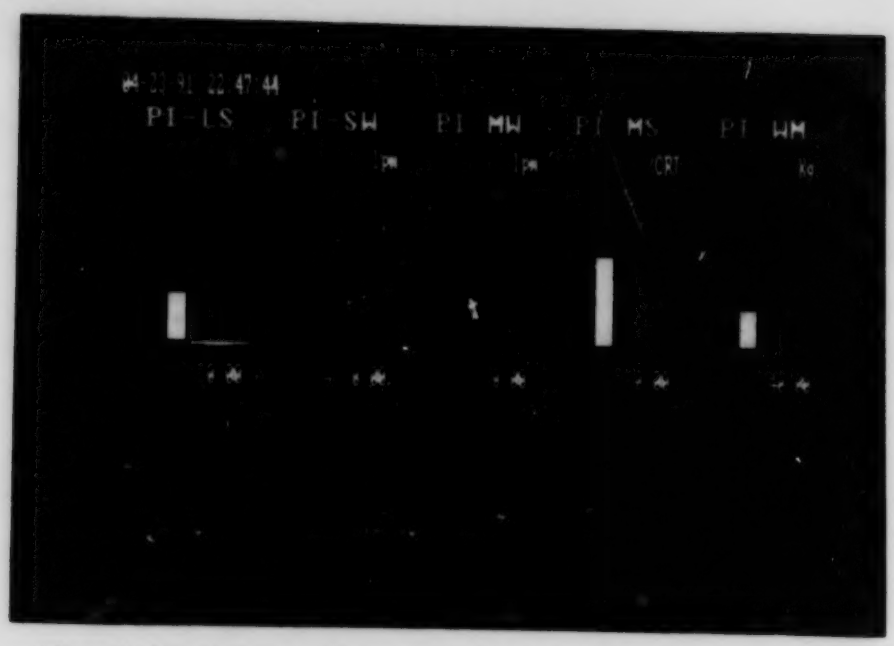

Figure 14. Control Overview Display for the 60cm SAG Mill Circuit at the University of British Columbia.

Figure 14 shows the control overview display (CNTRLOV), which is similar to a row of PID controller faceplates. Help is available in any display by hitting the <F1> key. In the upper left corner the date and time are shown. To the right of the time is the alarm window. The small bars along the top flash (one for each measured or calculated circuit parameter) when an alarm is active. In addition the last alarm message is displayed in the small window in the upper right of the display. The buttons across the bottom are key macros, they are used to move to other displays. The CONTROL Overview button is dimmed and has no <F key> to show it is the current display.

The controller faceplates show the current calculated and measured real time values of weights, flows, etc. The tag name definitions are:

Tag Name	Nomenclature
PI-LS	proportional integral controller for level in the sump
PI-MS	proportional integral controller for mill speed
PI-MW	proportional integral controller for mill water
PI-SW	proportional integral controller for sump water
PI-WM	proportional integral controller for weight of the mill

Key macros are used to override the computer's control of the PID controllers in the display, ie. to change manual/automatic modes, level setpoint, and feed rate, etc. A list of the key macros needed for this display is available by hitting the <F1> key.

Trends Overview:

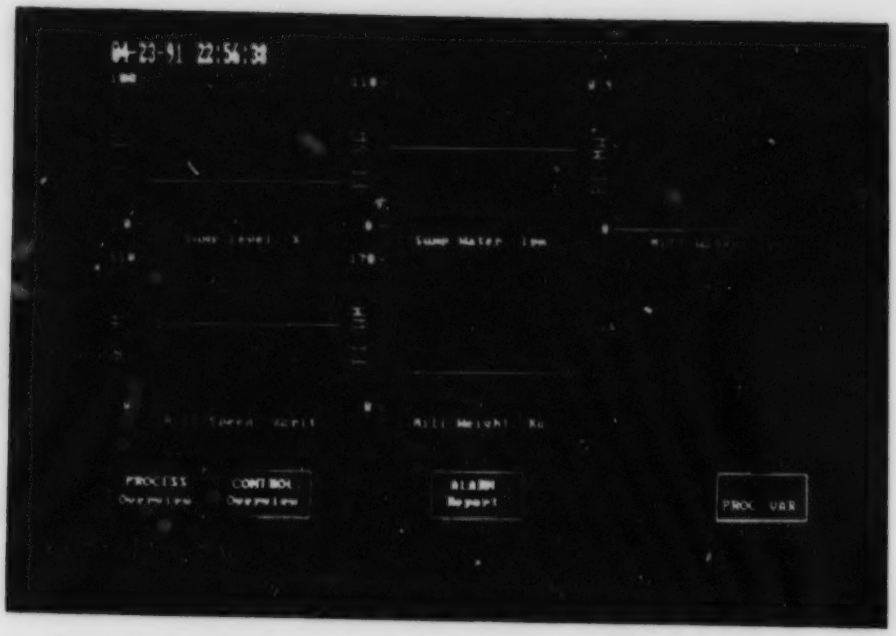

Figure 15. Controller Value(s) Trend Display for the 60cm SAG Mill Circuit at the University of British Columbia.

Figure 15 and 16 show the trend displays (CNTRLTR and PVARTR) available to the user. Help is available in any display by hitting the <F1> key. In the upper left corner the date and time are shown. To the right of the time is the alarm window. The small bars along the top flash (one for each measured or calculated circuit parameter) when an alarm is active. In addition the last alarm message is displayed in the small window in the upper right of the display. The buttons across the bottom are key macros, they are used to move to other displays. The <F7> and <F8> keys toggle between the two trend displays. The TRENDS Overview button is dimmed and has no <F key> to show it is the current display.

The trends provide a picture of the circuits behavior for the last five minutes. No control actions are possible from these displays.

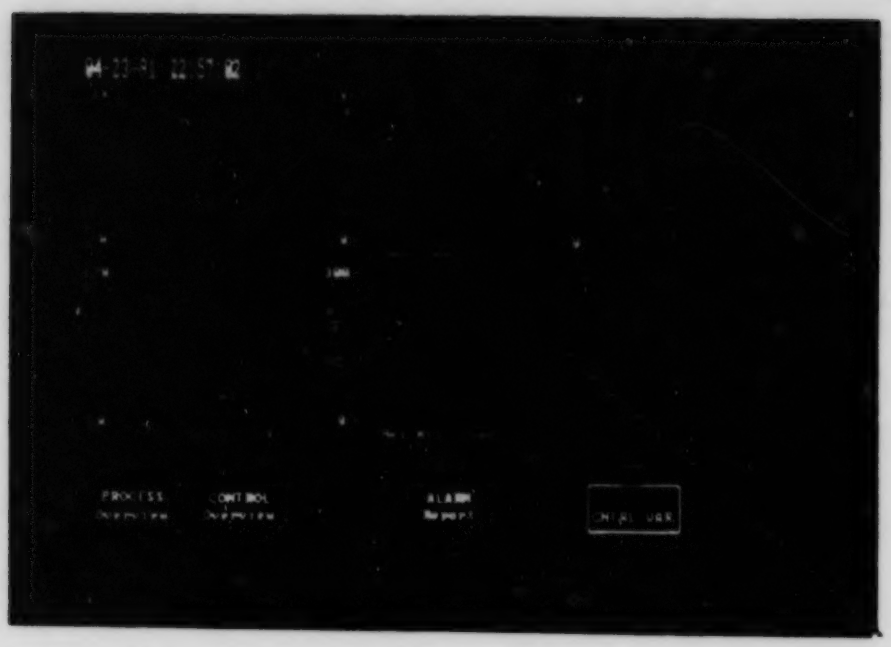

Figure 16. Process Value(s) Trend Display for the 60cm SAG Mill Circuit at the University of British Columbia.

Alarm Report:

Figure 17. Alarm Report Display for the 60cm SAG Mill Circuit at the University of British Columbia.

Figure 17 shows the alarm report display (ALOVIEW). Help is available in any display by hitting the <F1> key. In the upper left corner the date and time are shown. The buttons across the bottom are key macros, they are used to move to other displays. The ALARM Report button is dimmed and has no <F key> to show it is the current display.

The report shows the last twenty system messages ie., alarms, motor contactor status, program block termination, etc. Old messages scroll off the top as new messages are added to the bottom of the list. A complete alarm history is in the alarm summary display, see the ACE FIX™ manual stored under the computer monitor at the SAG mill. No control actions are possible from this display.

Other Displays:
Displays are available for tuning the control loops and trending the parameters for each of the loops. They are described in Appendix B. The calibration display is described in Appendix D calibrating Sensors.

Four circuit streams are sampled before and during the steady state operation. Begin sampling the circuit after the startup has been completed, ie. mill weight controller switches from manual to automatic. The sampling period is approximately one hour. Table 3 summarizes the samples that are taken. The mill discharge and screen undersize are sampled most frequently. A cut or sample of these two streams is taken every eight minutes and are placed in their respective tared sample containers.

Table 3. Sampling Schedule for the 60cm SAG Mill Circuit at the University of British Columbia.

Sample	Type	No. of Samples
Fresh feed	one shovel, taken from vibrating feeder trough Note: shovel is stored beside the feeder	two or three samples/test
Mill discharge	15s sample Note: pan is stored under the counter beside the mill	eight samples/test
Screen oversize	one batch Note: scoop is stored beside the screen	two or three samples/test
Screen undersize	5s sample Note: bucket is stored under the counter beside the mill	eight samples/test

The fresh feed and screen oversize samples are taken at the beginning and end of the run. It is important not to over sample these streams as it may disturb steady state conditions. However, it may be necessary to take an additional sample midway through the run. The fresh feed sample is taken from the vibrating feeder trough using the small shovel (kept by the vibrating feeder). Oversize is sampled by placing the small scoop (stored near the vibrating screen) in the oversize funnel below the oversize bin door. When the door opens catch the oversize as it falls into the funnel.

The mill discharge is sampled at the yellow mill discharge pipe. Replace the 19mm sieve with the small round pan stored under the counter beside the SAG mill. Screen undersize is sampled with a large bucket (stored under the counter beside the SAG mill), just lift the flexible hose from the drum thickener and into the bucket. Weigh, dry, and screen all samples.

The circuit normally reaches steady state within one hour of the start of a run. The user must determine when this occurs by looking at the process values given in the displays. When the circuit has reached steady state go to the process overview display, <F3>. The steady state part of the run ends when steady state has been reached.

Summary Report, Shut Down and Post-Operation Check List

The following procedure gives the steps necessary stop a run in a safe and consistent manner. The control system allows simple, automatic shutdown with very little operator input.

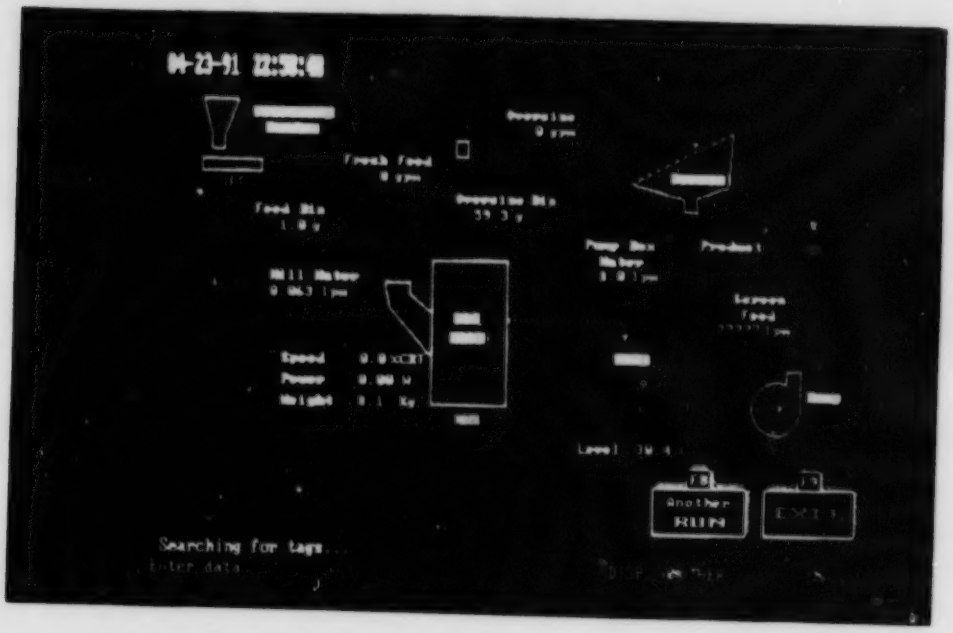

Figure 18. Shutdown Sequence Display for the 60cm SAG Mill Circuit at the University of British Columbia.

Apparatus:

- Eye and ear protection
- Bucket(s)
- Scoop
- Plastic bin(s)
- Pan(s)
- Broom

Material:

n/a

Figure 19. Exit FIX ACE™ Display for the 60cm SAG Mill Circuit at the University of British Columbia.

Procedure:

1. When the sampling has been completed and the circuit has reached steady state go to the process overview display, hit <F3>. To generate the summary report hit the <F8> key. The screen will go blank until the printing is finished (about two minutes). An example of the report is given in Appendix C. It gives the name, date, startup parameters, and average process values for the run. After the report is generated the circuit is shutdown, hit the <F9> key to go to the shutdown sequence display (S1). Help is always available by hitting the <F1> key, it tells you the actions that are possible in the display you are viewing.

2. Figure 18 shows the shut down sequence display. The user either begins another run with different startup parameters or exits the SAG circuit control system. The <F8> key goes to the startup parameter screen (see Pre-Operation Check List and Startup). The <F9> key brings the user to the final shutdown procedure, figure 19. Help is always available by hitting the <F1> key, it tells you the actions that are possible in the display you are viewing. After completing the first six steps in the checklist, hit the <F2> key to go to the main menu. Be alert, inspect the circuit as you go through the shutdown procedure. If there is any broken, missing or damaged equipment fix it immediately!

3. Shut off the mill power at the Ratiotrol™ mill motor actuator. Do the following to dump the mill charge. Disconnect the drive shaft at the mill. The Allen wrench is in the blue tool box under the mill motor speed reducer. Pull the shaft from the keyed gear reducer output shaft. Next, remove the yellow mill discharge pipe. Place a large grey bin under the mill on the large yellow plate.

Put the large aluminum trough between the mill supports and into the grey bin to deflect the mill contents into the bin. It is stored on the floor under the mill motor gear reducer. Attach a thin sling to the top two toggle clamps on the mill and use the crane to put the sling under moderate to light preasure. Undo the toggle clamps and gently pry the door off with a large screwdriver. Use a measured amount of water to wash off the mill door, be careful to catch the water on the trough and in the bin. Hoist door away and to one side of the mill.

Empty the mill contents into the grey bin, wash the mill with a measured amount of water. Wash out the discharge pipe. Replace the mill door, mill discharge pipe, and the drive shaft. Recover the steel charge, weigh, dry, calculate percent solids, and do a screen analysis.

4. Turn off the water supply valve, located above your head and to the right when you are facing the counter. Next, turn off the compressed air supply valve, located to the left and above the far right (air panel box) panel box. Drain the air pressure by pushing the valve in the bottom of the air filter, located in the air panel box. Open the middle (power panel box) and switch off the 110VAC and 208VAC power circuit breakers.

5. Open the drain plug, in the pipe tee between the centrifugal pump inlet and the sump discharge. Wash out the 19mm sieve and the sump.

6. Climb the ladder to the orange mezzanine platform. Empty the feed hopper and trough. Add two to four pans of crushed ore to the feeder hopper. Inspect the fresh feed and oversize apparatus; make sure they are clean and can move freely. Clean up the circuit.

7. Hit the <F2> key to go to the main menu. This ends the shut down of the SAG mill control program. Before shutting down the FIX™ be sure to terminate the Historical Data Collection (HTC) program. The next section discusses the use of the data collection program, including how to shut it off. The HTC program manual is in the FIX ACE™ manual stored under the monitor at the SAG mill. When the HTC has been shut down hit <F10>, type <ALT> <y> to shut down the fix and return to DOS. Typing '<go> <ENTER>' will start the control program again. Reset or turn off the computer to remove the memory resident FIX ACE™ programs.

Using the Historical Data Collect(ed)

The Historical Data Collection (HTC) program enables the user to collect process data, save this data to disk, and display the data as reports, or charts. The data can be viewed using the historical data display package in the control software. Hard copy reports and trends are also available. The data can be exported as ASCII or Lotus™ PRN files. The data collection is done automatically and starts when the system is started. Each day the program is run a new file is created by the HTC program. It begins at midnight and ends one second before midnight of the next day. The data can be viewed using the historical data display package in the control software. Hard copy reports and trends are available by using the software.
If more than one run is done in a day they will both be stored in one file. Remember to backup your data to floppy disk(s). The file name format is,

C:\FIXDIR\HTR\YYMMDD00.H24

where,
C:\FIXDIR\HTR\= the path to the historical data files
YY = year the file started
MM = month the file started
DD = day the file started
00 = hour the file started, 24hr clock
H24 = designates a 24 hour file length

The user must stop the HTC before exiting the FIX ACE™ or the data for the current day may be lost. To stop the HTC go to the main menu, if it is running there is an asterisk by the HTR entry in the background task menu. Type <HTC> <ENTER> follow the prompts, ie. type <E> and then <Y>. You will return to the main menu.

Table 1 shows the data that is collected on the circuit. All values are updated every six seconds, and stored as one minute averages. The HTC program is a very flexible tool for analyzing the data generated during a run. The Historical Data Display (HDD) program, it displays historical data file(s), can also be run from DOS by typing <HDD e> <ENTER>. Please refer to the HTC program section in the FIX ACE™ manual stored under the monitor at the SAG mill for any details on using the HTC program.

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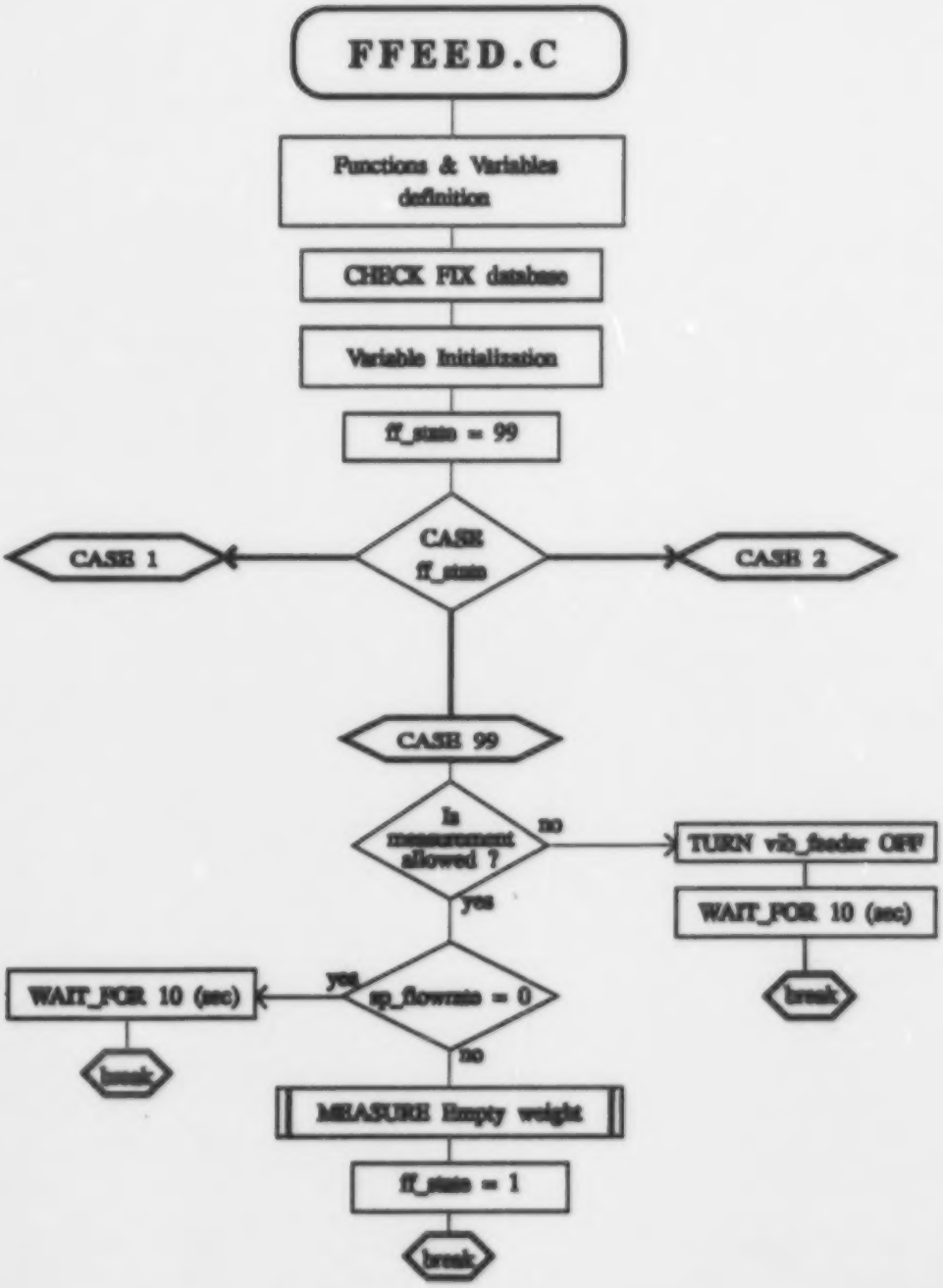
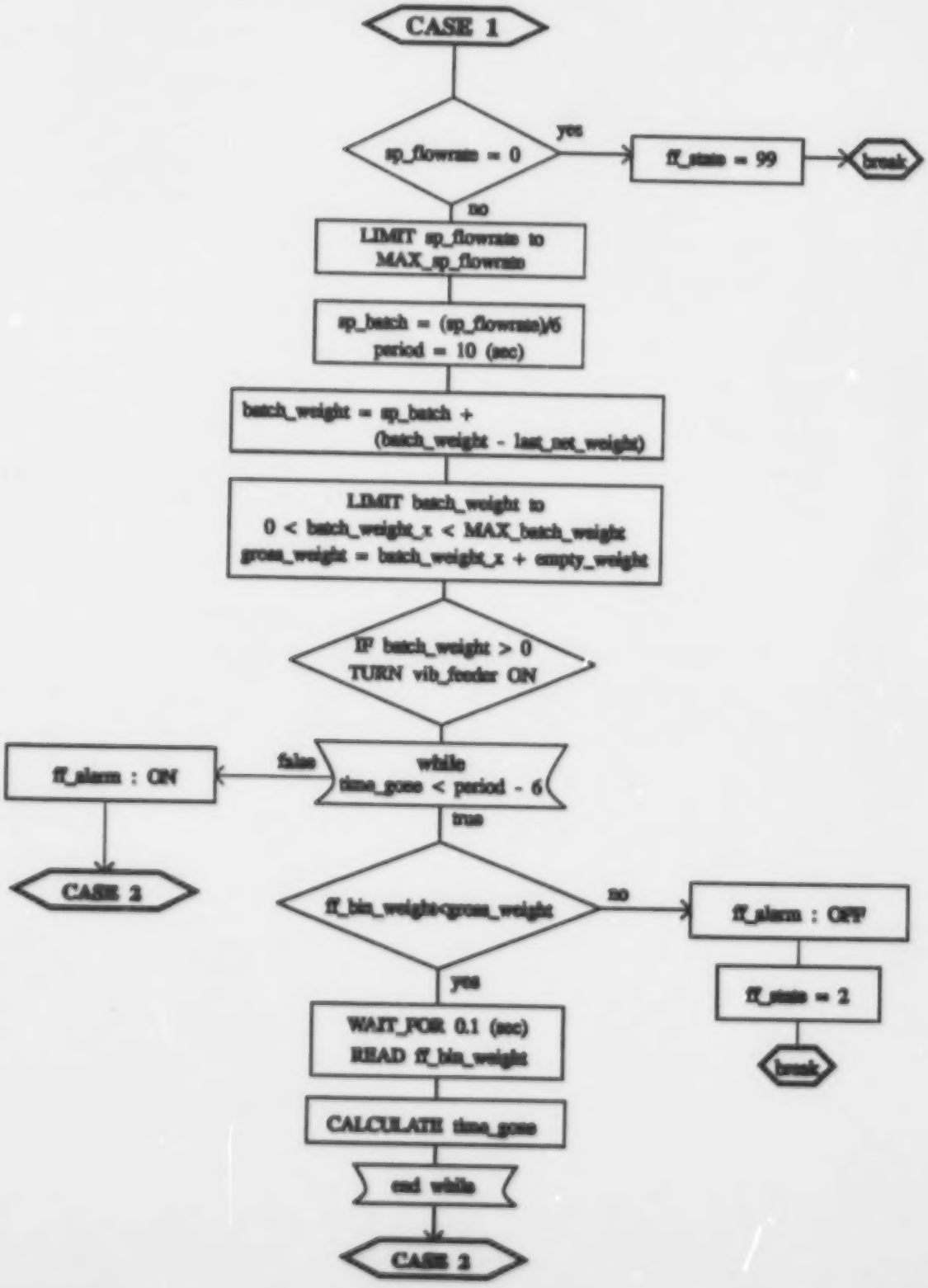
Appendix A:
Fresh Feed and Oversize Control Programs

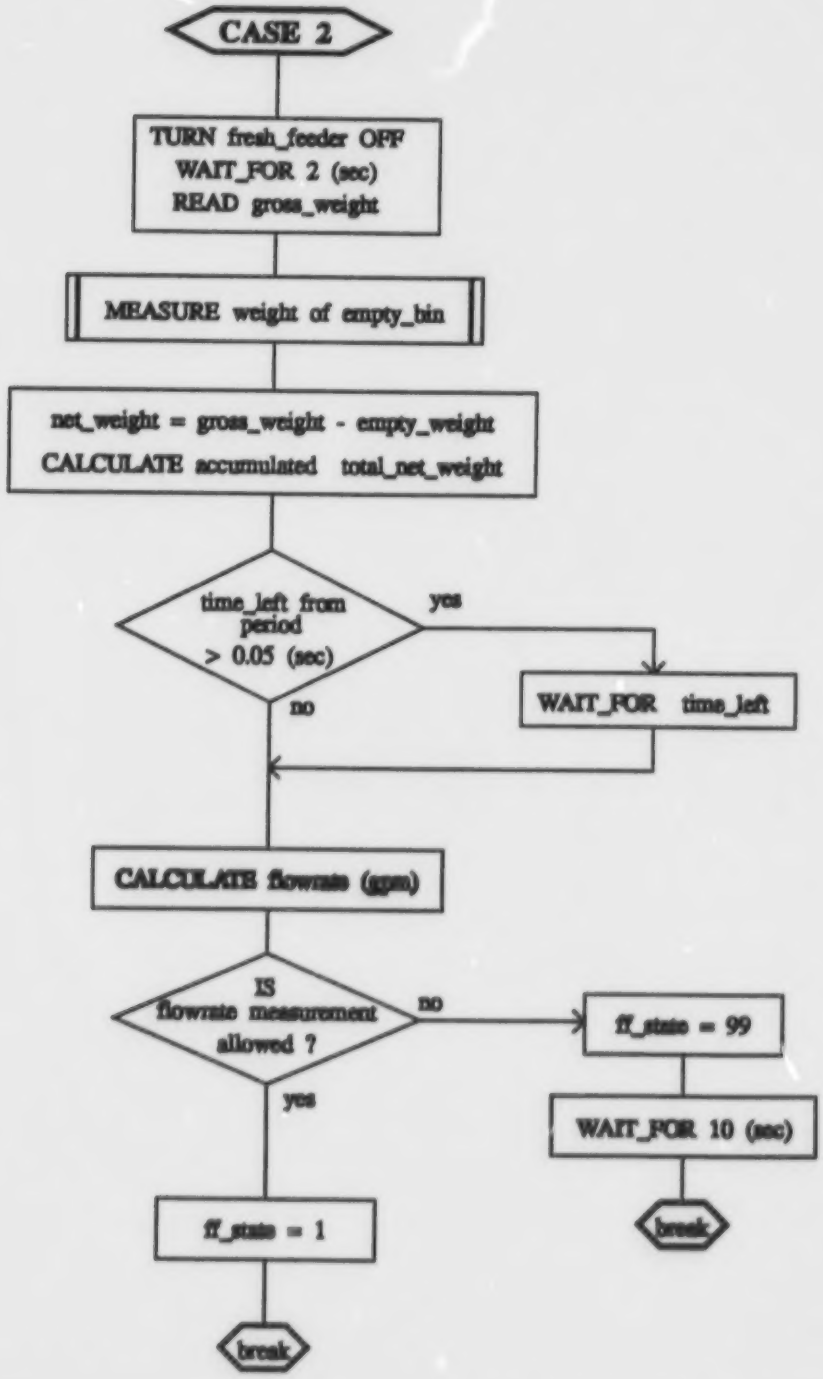
FFEED.C Flow Diagram



FFEED.C Flow Diagram (cont.)



FFEED.C Flow Diagram (cont.)



```
/*****************************************************************************
 *
 *                          " FFEED.C "
 *
 *      Main routine designed to measure and control the fresh feed
 *      flowrate to the mill. It interacts with the FIX database to
 *      read/write information.
 *
 *      Its operation is controlled by the flag "DOD-FLAG". When it is ON
 *      (equal 1), it calculates and controls the fresh feed. When it is
 *      OFF (equal 0), it is on an idle state
 *
 *****************************************************************************/

#include <stdlib.h>
#include <stdio.h>
#include <string.h>
#include <conio.h>
#include <dos.h>

/***     includes the headers FIX needs in order to run
***/
#include "fixuser.h"
#include "dbafpt.h"
#include "exelib.h"

/***     defines the value of text used in the program
***/
#define ALT_X  0x2D
#define CLOSE_BIN 0
#define OPEN_BIN 1
#define ON 1
#define OFF 0
#define TRUE 1
#define FALSE 0

/*****************************************************************************
Specification of the different functions and variables used in the program.

  FUNCTIONS:
        test_exit: It gives the user the alternative of EXIT and
                        END the execution of the main program (ffeed.c) -
                        <y>; or to go to the FIX main menu and leave
                        the program running - <ALT-X>.

        read_FIX        : Reads the specified point in the FIX database.

        write_FIX       : Writes information to an specific point in the
                          FIX database.
        wait_for: Waits for a specific time (in seconds).
        time_now        : Reads the current system time.
```

```
        check_version    : Checks for the proper FIX version.

        Check_dbase      : Checks for the initialization of the FIX database.

        check_tag_range : Checks for errors on the tags and range of the
                          different points in the FIX database. Matches
                          tag names and GBI variables used in this program.

   VARIABLES:
                GBI      : Global block information. A structure that contains
                           the block type and block number.
*****************************************************************************/

int     test_exit( void);
double  read_FIX (GBI ff );
void    write_FIX (GBI ff, double x);
void    wait_for ( double x);
double  time_now (double *x);
void    main (void);
void    check_version(void);
void    check_dbase(void);
void    check_tag_range (char tag[20]);

char    *err, tag[20];
GBI     ff_bin_weight, sp_ff_flowrate, ff_meter, ff_vib_feeder, ff_bin_gate;
GBI     ff_alarm, ff_flowrate, total_ffeed, print_report;

double  net_weight [10], last_net_weight,  net_weight_accum, total_fresh_feed;
double  gross_weight, empty_weight, weight, batch_weight, sp_batch;
double  batch_weight_x;
double  flowrate, sp_flowrate, MAX_sp_flowrate, MAX_batch_weight ;
double  time_gone, initial_time, last_time, period, time_left;
double  time_interval [10], time_accum, status;

float   lo_ff_bin, hi_ff_bin, lo_ff_flowrate, hi_ff_flowrate ;
float   lo_sp_ff, hi_sp_ff, lo_total_ffeed, hi_total_ffeed;

int     fmt, batch_i, ff_state, number, number_batches;

/***    MAIN routine
***/
void main()
{
int idx, i;
/***    check version and FIX database initialization
***/
         check_version ();
         check_dbase ();

/***    check the tags and engineering. units in the FIX database
***/
         check_tag_range ("AIF-FB");
         check_tag_range ("AID-FF");
         check_tag_range ("AOD-TFF");
```

```
            check_tag_range ("PI-WM");
            check_tag_range ("DOF-VF");
            check_tag_range ("DOF-FB");
            check_tag_range ("DOD-FF-AL");
            check_tag_range ("DOD-FLAG");

/***     initializes the fresh feed totalizer
***/
            total_fresh_feed = 0;

/***     Maximum set point for the fresh feed flowrate
***/
            MAX_sp_flowrate = 2400;

/***     Maximum batch weight allowed for the fresh feed bin
***/
            MAX_batch_weight = 400;

/***     number of batch weights used to calculate the mean
        value for the fresh feed flowrate
***/
            number_batches = 6;

/***     Initial value of the FLAG that controls the sequence of
        steps concerning the measurement and control of the
        fresh feed flowrate.
***/
            ff_state = 99;

/***     Continues the execution unless a <y> is entered by the user
***/
  while ( test_exit()       )
  {

/***     Selects the specific task in the measurement and
        control of the fresh feed
***/
  switch ( ff_state )
  {
  case 1:
            initial_time = last_time;

/***     reads the set point for the fresh feed flowrate. If it is zero
        goes to an idle state where does not activates the feeder
        nor the bin door, and sets the flowrate to zero. If it is not
        zero, continues with the activities of measuring and controlling
        the flowrate.
***/
            sp_flowrate = read_FIX ( sp_ff_flowrate );

        if( sp_flowrate == 0 )
        {
        ff_state = 99;
        break;
```

```
        }
          if ( sp_flowrate > MAX_sp_flowrate )
                {
                sp_flowrate = MAX_sp_flowrate ;
                write_FIX ( sp_ff_flowrate, sp_flowrate);
                }

/***    sets the setpoint for the batch weight and
       the period of time between batches.
***/
          sp_batch = sp_flowrate/6;
          period = 10;                  /* seconds */

/***    determines the next batch weight in the bin
***/
          batch_weight = sp_batch + ( batch_weight - last_net_weight );

/***    limits the batch weight that is going to ask for
***/
          if ( batch_weight        < 1   ) {
                batch_weight_x = 0;}
          else if ( batch_weight   > MAX_batch_weight ){
                batch_weight_x = MAX_batch_weight ;}
          else
                batch_weight_x = batch_weight;

          gross_weight = batch_weight_x + empty_weight;


/***    fresh feed goes into the bin. It waits until it reaches the batch
       weight specified and then it stops the feeder. If the maximum
       waiting time is reached before the batch weight it also stop the
       feeder and set an alarm ("DOD-FF-AL")
***/
          if ( batch_weight_x > 0 ) write_FIX ( ff_vib_feeder, ON);

cprintf (" \r\n SP_batch_weight:  %f \r\n",sp_batch);
cprintf ("  batch_weight:  %f \r\n",batch_weight);
cprintf ("   empty_weight:  %f \r\n",empty_weight);

                time_gone = 0;     weight = 0;
                while ( time_gone < period - 6.0 )

/***    '6.0' it is the total time spent before filling the bin
***/
                {
                if ( weight < (gross_weight ) )
                  {
                  wait_for (0.1);
                  weight = read_FIX ( ff_bin_weight );

/*** cprintf (" weight:  %f \r",weight);
***/
                }
```

```
                else {
                  write_FIX ( ff_alarm, OFF );
                  ff_state= 2;     break; }

/***     calculates the time passed by since the last batch
***/
                time_gone = time_now (&last_time) - initial_time ;
                }
            write_FIX ( ff_alarm, ON );

  case 2:

/***     measures the gross weight of the bin
***/
            write_FIX ( ff_vib_feeder, OFF );
                wait_for (2);
            gross_weight= read_FIX ( ff_bin_weight ) ;

/***     measures the weight of the empty bin
***/
            write_FIX ( ff_bin_gate, OPEN_BIN );
                wait_for (1);
            write_FIX ( ff_bin_gate, CLOSE_BIN );
                wait_for (3.0);
            empty_weight = read_FIX ( ff_bin_weight ) ;

/*** calculates the "net weight" of the ore in the bin
***/
            net_weight [batch_i] = gross_weight - empty_weight;

            if ( net_weight[batch_i] < 0 ) net_weight[batch_i] = 0;
            last_net_weight = net_weight[batch_i];

cprintf ("\r\n              net weight:  %f \r\n",last_net_weight);

/***     adds the net weight to the fresh feed totalizer
***/
                total_fresh_feed = read_FIX ( total_ffeed);

                total_fresh_feed += last_net_weight/1000;
                write_FIX ( total_ffeed, total_fresh_feed );

/***     checks if there is any time left in the batch time
***/
            time_gone = time_now (&last_time) - initial_time;
            time_left = period - time_gone;

/***     waits for the time left, if any. The variable "last_time" takes
        the last reading of the system time
***/
            if ( time_left > (float) 0.05 )
              {
              wait_for (time_left);
              time_interval [batch_i] = time_now (&last_time) - initial_time;
```

```
        }

      else
        time_interval [batch_i] = time_gone;

/***   calculates the flowrate of fresh feed in grams per minute as the
      mean value of the last "number" batch weights; where "number"
      is set to one at the beginning of this algorithm and every time
      that the fresh feed flowrate is set to zero.
***/
        if ( ++number > number_batches ) number = number_batches;

        net_weight_accum = 0;          time_accum = 0;
        for ( idx = 1 ; idx <= number; idx++)
        {
        net_weight_accum += net_weight [idx];
            time_accum += time_interval [idx];
        }

       flowrate = 60 * net_weight_accum / time_accum;

cprintf (" \r\n    flowrate: %f \r\n",flowrate);

/***   sends back to the FIX the flowrate calculated
***/
         write_FIX ( ff_flowrate, flowrate );

/***   sets the index for the next batch weight
***/
        if( ++batch_i > number_batches ) batch_i = 1;

        ff_state = 1;

/***   checks for the flag (DOD-FLAG) that allows the measurement and
      control of the fresh feed to work
***/
            status = read_FIX ( ff_meter );

            if ( status == OFF )
            {
            ff_state = 99;      wait_for(10);
            }
      break;

  case 99:

/***   checks for the flag that allows the measurement and control of the
      fresh feed to work
***/
            status =  read_FIX ( ff_meter );

            if ( status == OFF )
            {
            cprintf( "waiting for DOD_FLAG .....\r\n" );
```

```
                write_FIX ( ff_vib_feeder, OFF);
                wait_for(10);
                break;
                }
/***     if the flag is ON (1), it checks for the flowrate setpoint.
        If this setpoint is zero, sets the fresh feed flowrate to zero
        in the FIX database.
***/
        sp_flowrate = read_FIX ( sp_ff_flowrate );

        if( sp_flowrate == 0 )
        {
          flowrate = 0;
          write_FIX ( ff_flowrate, flowrate );
          wait_for(10);
          break;
        }
/***     if the set point of the fresh feed flowrate is not zero,
        it initializes some variables
***/
          batch_i= 1; number = 0;
          batch_weight = 0 ;        last_net_weight = 0 ;
          for (i=1; i <= number_batches; i++) {
                time_interval[i] = 0; net_weight[i]= 0;}

/***     measures the weight of the empty bin
***/
          write_FIX ( ff_vib_feeder, OFF);
          write_FIX ( ff_bin_gate, OPEN_BIN);
                wait_for (2.5);
          write_FIX ( ff_bin_gate, CLOSE_BIN);
                wait_for (4);

          empty_weight = read_FIX ( ff_bin_weight );

/***     sets the initial time for the batch weight
***/
          initial_time = time_now ( &last_time );

          ff_state= 1;

   } /* end of switch */
   } /* end of while */

} /* end of main */
/*****************************************************************************/

/*** checks version and database initialization
***/
void check_version()
{
        if (!e_vers()) {   cprintf("vers error \r\n");
          wait_for(3);exit( 1);
```

```
        }
}
void check_dbase()
{
        err = dbainit();
        if ( err ) { cprintf( "init error \r\n");
          wait_for(3);exit( 1);
        }
}

/*** checks the TAG and the RANGE of different points in the FIX database
***/
void check_tag_range (char tag_id[20])
{
  if ( !strcmp( tag_id, "AIF-FB") )
        {
        err= taggbi( tag_id, &ff_bin_weight);
        if ( err ) { cprintf( "tag1 error\r\n"); exit( 1); }
                err= dbagcve( &ff_bin_weight, &lo_ff_bin, &hi_ff_bin, &fmt);
        if ( err ) { cprintf( "range value error\r\n"); exit( 1); }
        }
  else if ( !strcmp( tag_id, "AID-FF") )
        {
        err= taggbi( tag_id, &ff_flowrate);
        if ( err ) { cprintf( "tag2 error\r\n"); exit( 1); }
        err= dbagcve( &ff_flowrate, &lo_ff_flowrate, &hi_ff_flowrate, &fmt);
        if ( err ) { cprintf( "range value error\r\n"); exit( 1); }
        }
  else if ( !strcmp( tag_id, "AOD-TFF") )
        {
        err= taggbi( tag_id, &total_ffeed);
        if ( err ) { cprintf( "tag2 error\r\n"); exit( 1); }
        err= dbagcve( &total_ffeed, &lo_total_ffeed, &hi_total_ffeed, &fmt);
        if ( err ) { cprintf( "range value error\r\n"); exit( 1); }
        }
  else if ( !strcmp( tag_id, "PI-WM") )
        {
        err= taggbi( tag_id, &sp_ff_flowrate);
        if ( err ) { cprintf( "tag error\r\n"); exit( 1); }
        err= dbagcve( &sp_ff_flowrate, &lo_sp_ff, &hi_sp_ff, &fmt);
        if ( err ) { cprintf( "range value error\r\n"); exit( 1); }
        }
  else if ( !strcmp( tag_id, "DOF-VF") )
        {
        err= taggbi( tag_id, &ff_vib_feeder);
        if ( err ) { cprintf( "tag error\r\n"); exit( 1); }
        }
  else if ( !strcmp( tag_id, "DOF-FB") )
        {
        err= taggbi( tag_id, &ff_bin_gate);
        if ( err ) { cprintf( "tag error\r\n"); exit( 1); }
        }
  else if ( !strcmp( tag_id, "DOD-FF-AL") )
        {
```

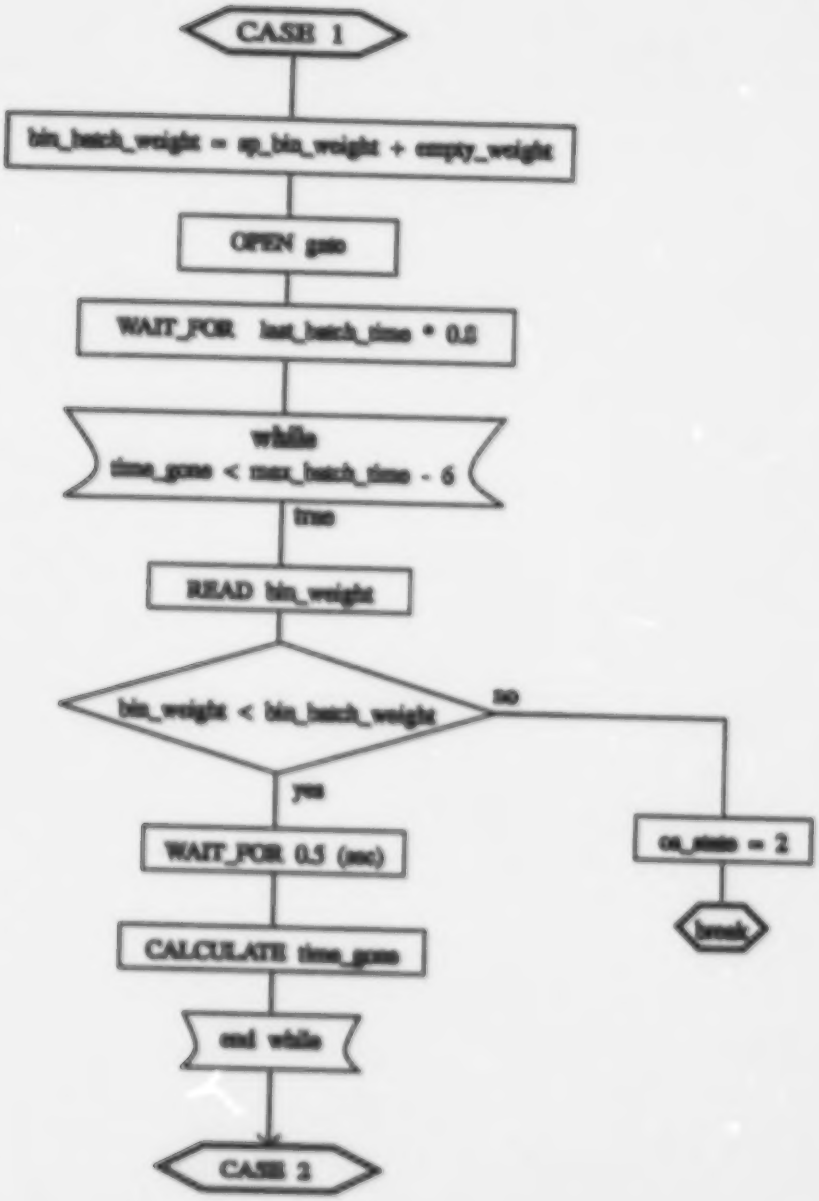
```
            err= taggbi( tag_id, &ff_alarm);
            if ( err ) { cprintf( "tag error\r\n"); exit( 1); }
            }
    else if ( !strcmp( tag_id, "DOD-FLAG") )
            {
            err= taggbi( tag_id, &ff_meter);
            if ( err ) { cprintf( "tag error\r\n"); exit( 1); }
            }
}

/***                 reading from the FIX database
***/
double read_FIX ( GBI tag_gbi )
{
int       ival;
char tag_id[20];

/***     converts the GBI variables into string characters
***/
  err = gbitag (tag_id, &tag_gbi);

  if ( !strcmp( tag_id, "AIF-FB" )) {
          err= dbagcv( &ff_bin_weight, &ival);
          return ( cve( hi_ff_bin, lo_ff_bin, ival) );
                  }
  else if ( !strcmp( tag_id, "AOD-TFF")) {
                  err= dbagcv( &total_ffeed, &ival);
                  return ( cve( hi_total_ffeed, lo_total_ffeed, ival) );
                  }
  else if ( !strcmp( tag_id, "PI-WM" )) {
                  err= dbagcv( &sp_ff_flowrate, &ival);
          return ( cve( hi_sp_ff, lo_sp_ff, ival) );
                  }
  else if ( !strcmp( tag_id, "DOD-FLAG" )) {
                  err = dbagcv ( &ff_meter, &ival);
                  return ( ival );
                  }
}

/***     writing  to FIX database
***/
void write_FIX ( GBI tag_gbi, double value )
{
int ival;
char tag_id[20];

/***     converts GBI variables into string characters
***/
  err = gbitag (tag_id, &tag_gbi);

  if ( !strcmp( tag_id, "AID-FF" )) {
                  ival = cvi(hi_ff_flowrate, lo_ff_flowrate, value );
                  err = dbapcv (&ff_flowrate, ival);
                  }
```

```
    if ( !strcmp( tag_id, "AOD-TFF" )) {
                    ival = cvi(hi_total_ffeed, lo_total_ffeed, value );
                    err = dbapcv (&total_ffeed, ival);
                    }
    else if ( !strcmp( tag_id, "DOD-FF-AL" )) {
                    ival = (int) value;
            err = dbapcv (&ff_alarm, ival );
                    }
    else if ( !strcmp( tag_id, "DOF-FB" )) {
                    ival = (int) value ;
                    err= dbapcv( &ff_bin_gate, ival );
                    }
    else if ( !strcmp( tag_id, "DOF-VF" )) {
                    ival = (int) value ;
            err= dbapcv( &ff_vib_feeder, ival );
                    }
} /* end of write */

/***   reads the current system time from the clock (in seconds).
        Returns the time and assigns it to the argument variable
***/
double time_now ( double *c_time )
{
struct dostime_t ti_time;

        _dos_gettime ( &ti_time );
        *c_time =  ti_time.hour * 3600.0 ;
        *c_time += ti_time.minute * 60.0 ;
        *c_time += ti_time.second ;
        *c_time += ti_time.hsecond / 100.0 ;
        return (*c_time);
}

/***     waits for certain specified time. It uses the e_sleep
        function provided by FIX
***/
void wait_for ( double t_time )
{
int sleep_time;

        sleep_time = (int) t_time*100 ;
        if ( sleep_time > 5 ) e_sleep( sleep_time );
        return;
}

/*** test_exit(): checks for keyboard input. Exits the program
                    if <Y> was pressed, or exits and leaves it
                    running when <ALT X> is entered.
***/
int test_exit( void)
{
int msb, lsb;

  if (kbhit())
```

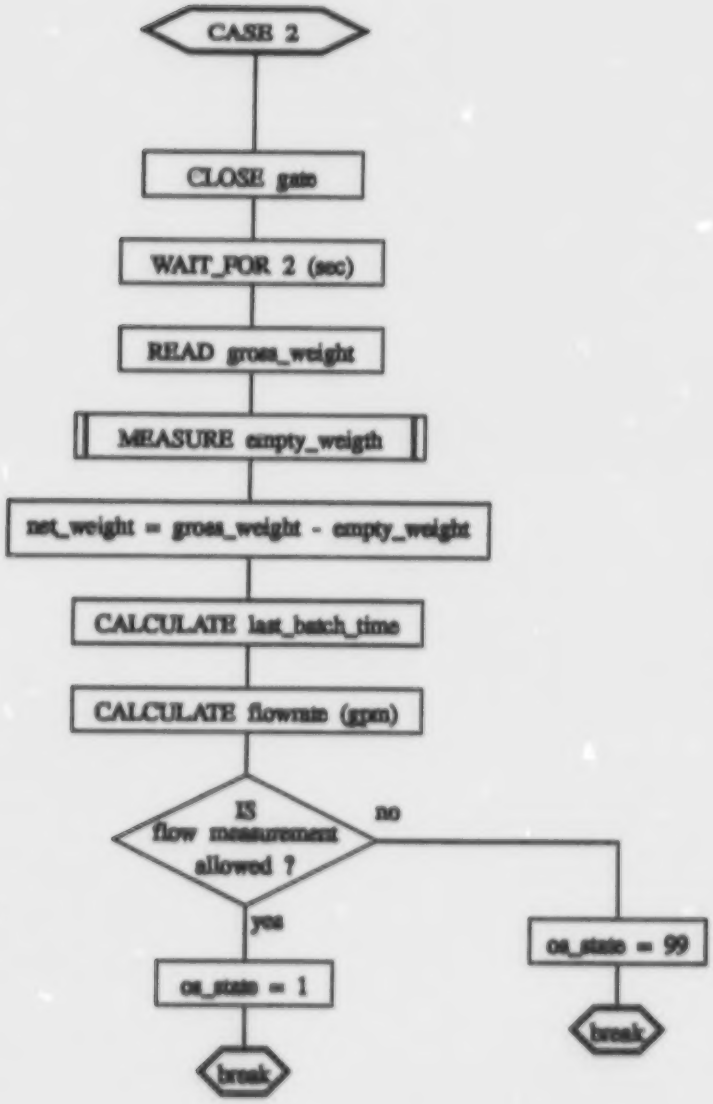
```
    {
      msb = getch();
      msb = toupper(msb);
            if ((kbhit()) && (msb == 0))
            lsb = getch();
            else
            lsb = 0;

      while (kbhit())         getch();     /* clear keyboard buffer */
            if ((msb == 'Y') || (lsb == ALT_X))
            return(FALSE);
            else
           cprintf("<Alt x> exits with task active or 'y' exits\r\n");
    }
    return(TRUE);
}
/*****************************************************************************/
```

OSIZE.C Flow Diagram

OSIZE.C Flow Diagram (cont.)



OSIZE.C Flow Diagram (cont.)



```
/*****************************************************************************
*
*                        " OSIZE.C "
*
*
*       OS.C is a routine designed to measure the oversize flowrate
*       returning to the mill. It measures batch weights on the oversize
*       bin and the time between measurements to calculate the flowrate.
*       The value reported is the mean value of the last four measurements.
*
*       When the flag "DOD-FLAG" is OFF (equal 0), the routine goes to
*       an idle state.
*****************************************************************************/

#include <stdlib.h>
#include <stdio.h>
#include <string.h>
#include <conio.h>
#include <dos.h>

/***     includes the headers that FIX needs in order to run
***/
#include "fixuser.h"
#include "dbafpt.h"
#include "exelib.h"

/***     defines the value of text used in the program
***/
#define ALT_X  0x2D
#define TRUE   1
#define FALSE  0
#define CLOSE 1
#define OPEN 0
#define CLOSE_DOOR 0
#define OPEN_DOOR 1
#define OFF 0
#define ON 1

/***
Specification of the different functions and variables used in the program.

  FUNCTIONS:
        test_exit: It gives the user the alternative of EXIT and
                        END the execution of the main program (osize.c) -
                        <y>; or to go to the FIX main menu and leave
                        the program running - <ALT-X>.

        read_FIX        : Reads the specified point in the FIX database.

        write_FIX       : Writes information to an specific point in the
                        FIX database.
        wait_for: Waits for a specific time (in seconds).
        time_now        : Reads the current system time.
```

```
        check_version    : Checks for the proper FIX version.

        check_dbase      : Checks for the initialization of the FIX database.
        check_tag_range  : Checks for errors on the tags and range of the
                           different points in the FIX database. Matches
                           tag names and GBI variables used in this program.

    VARIABLES:
                GBI      : Global block information. A structure that contains
                           the block type and block number.

*****************************************************************************/

void main(void);
int test_exit( void);
void check_version(void);
void check_dbase(void);
void check_tag_range (char tag[20]);
double read_FIX ( GBI ff);
void write_FIX (GBI ff, double f);
void wait_for (double f);
float time_now (float *f);

GBI     os_bin_weight, os_flowrate, sp_os_bin_weight ;
GBI     os_gate,os_bin, os_meter;

double  bin_weight, gross_weight, empty_weight, net_weight [10];
double  net_weight_accum, sp_bin_weight, bin_batch_weight, flowrate, status;
double  last_batch_time;

float   lo_bin_weight, hi_bin_weight, lo_os_flowrate, hi_os_flowrate;
float   lo_sp_bin_weight, hi_sp_bin_weight;
float   time_interval[10], initial_time, time_accum, last_time, time_gone;
float   max_batch_time;
char *err;
int fmt, number_batches;

/***    MAIN routine
***/
void main()
{
int     i, batch_i, os_state;

/***    checks the version and the initialization of the FIX database
***/
        check_version();
        check_dbase();

/***    checks errors in the tag name and range of the different
        points of the FIX database used in the program
***/
        check_tag_range ("AIF-OB");
        check_tag_range ("AID-OS");
        check_tag_range ("AOD-OBAT");
```

```
        check_tag_range ("DOF-OB");
        check_tag_range ("DOF-OG");
        check_tag_range ("DOD-FLAG");

/***    defines the number of batch weight it is going to use
        to calculate the flowrate.
***/
        number_batches = 4;

/***    defines the maximum time it will wait to reach the gross bin
        weight specified by the user
***/
        max_batch_time = 40 ;    /* (seconds) */

/***    the initial state of the oversize flowmeter is idle (os_state=99)
        It waits until the flag (DOD-FLAG) is set to one (ON).
***/
        os_state= 99;

/***    checks for keyboard input. If a <y> is entered it exits the program.
        <ALT X> leaves the program running and returns to the FIX main menu.
***/
  while ( test_exit() ) {

/***    selects the specific activities to be performed according to the
        value of os_state
***/
        switch( os_state)
        {
        case 1:                  /* wait for oversize bin to be filled */

/***    reads the maximum batch weight specified by the user, and
        determines the gross bin weight it has to wait for
***/
                sp_bin_weight = read_FIX ( sp_os_bin_weight );
                bin_batch_weight = sp_bin_weight + empty_weight;

                  write_FIX ( os_gate, OPEN);

/***    goes to sleep for 80 % of time associated with the last batch time
***/
          wait_for ( last_batch_time * 0.80 );

/***    waits until the specified gross weight or until the maximum batch
        time is reached. Then it proceeds to measured the bin weight.
***/
                time_gone = 0 ;
                while ( time_gone < max_batch_time -6 )

/***  '6' is the accumulated idle time on 'wait_for' functions on each cycle
***/
                {
                bin_weight = read_FIX ( os_bin_weight );
                if ( bin_weight < bin_batch_weight ) {
```

```
                wait_for (0.5);
                }
              else {
                os_state = 2;   break;}

              time_gone = time_now (&last_time) - initial_time;
              }
        case 2:

/***   after the batch weight or the maximum time has been reached,
      the gate is closed and the bin weight is measured
***/
              write_FIX ( os_gate, CLOSE);
              wait_for (2);

/***   measures the gross weight of the bin
***/
              gross_weight = read_FIX ( os_bin_weight);

              write_FIX ( os_bin, OPEN_DOOR);
              wait_for (1);
              write_FIX (os_bin, CLOSE_DOOR);
              wait_for (3);

/***   measures the empty weight of the bin and calculates the net weight
***/
              empty_weight = read_FIX ( os_bin_weight );

              net_weight [ batch_i] = gross_weight - empty_weight;

/***   calculates the time interval associated with the last batch weight
***/
          time_interval [batch_i] = time_now (&last_time) - initial_time;
              initial_time = last_time;
              last_batch_time = time_interval [batch_i];

              if ( ++batch_i > number_batches ) batch_i = 1;

/***   calculates the oversize flowrate in grams per minute, as the mean
      value of the last four measurements
***/
                net_weight_accum = 0;   time_accum = 0;
                    for ( i = 1; i <= number_batches; i++ ) {
                    net_weight_accum  += net_weight [ i];
                    time_accum += time_interval [ i];
                    }
            flowrate = 60.0 * net_weight_accum / time_accum;

/***   writes the calculated flowrate back to the FIX database
***/
              write_FIX ( os_flowrate, flowrate);
              os_state = 1;

/***   checks for the status of the flag (DOD-FLAG) that activates the
```

```
        flowrate measurement. If it is OFF it goes to an idle state until
        it is set ON
***/
                    status = read_FIX ( os_meter );
                    if ( status == OFF )
                    {
                    os_state = 99 ;   wait_for(10);
                    }
                  break;

        case 99:

/***     Idling state: waiting for the flag DOD-FLAG to be ON to start.
        It checks the flag every 10 sec.
        It opens the gate and door of the bin.
***/
                    status = read_FIX ( os_meter );
                    if ( status == OFF )
                    {
                    cprintf( "waiting for DOD-FLAG .....\r\n" );
                    write_FIX ( os_gate, OPEN);
                    write_FIX ( os_bin, OPEN_DOOR);
                    wait_for (10);
                    break;
                    }

/***     when the flag DOD-FLAG is ON (equal 1) it initializes some
        variables
***/
                  batch_i = 1 ;
              for (i=1; i <= number_batches; i++)
                    { time_interval[i] = 0; net_weight[i]= 0;}

                  write_FIX ( os_gate, CLOSE);
                  write_FIX ( os_bin, OPEN_DOOR);
                    wait_for (2);
                  write_FIX (os_bin, CLOSE_DOOR);
                    wait_for (3);
                  empty_weight = read_FIX ( os_bin_weight );

                  initial_time = time_now ( &last_time );
                  os_state = 1;

        }  /* end of switch */
    }     /* end of while */
}  /* end of main */
/*****************************************************************************/

/*** checks version and database initialization
***/
void check_version()
{
        if (!e_vers()) {   cprintf("vers error\r\n");
          wait_for(3);exit( 1);
```

```
            }
}

void check_dbase()
{
char *err;

        err = dbainit();
        if ( err ) { cprintf( "init error\r\n");
           wait_for(3);exit( 1);
           }
}

/*** checks the TAG and the RANGE in the FIX database
***/
void check_tag_range (char tag_id[20])
{
  if ( !strcmp( tag_id, "AIF-OB"))
        {
        err= taggbi( tag_id, &os_bin_weight);
        if ( err ) { cprintf( "tag error\r\n");  wait_for(3);exit( 1); }
        err= dbagcve( &os_bin_weight, &lo_bin_weight, &hi_bin_weight, &fmt);

        if ( err ) { cprintf( "range value error\r\n");
           wait_for(3);exit( 1); }
        }
 else if ( !strcmp( tag_id, "AID-OS"))
        {
        err= taggbi( tag_id, &os_flowrate);
        if ( err ) { cprintf( "tag error\r\n");  wait_for(3);exit( 1); }
        err= dbagcve( &os_flowrate, &lo_os_flowrate, &hi_os_flowrate, &fmt);
        if ( err ) { cprintf( "range value error\r\n");
           wait_for(3);exit( 1); }
        }
 else if ( !strcmp( tag_id, "AOD-OBAT"))
        {
        err= taggbi( tag_id, &sp_os_bin_weight);
        if ( err ) { cprintf( "tag error\r\n");  wait_for(3);exit( 1); }
        err= dbagcve( &sp_os_bin_weight, &lo_sp_bin_weight, &hi_sp_bin_weight, &fmt);
        if ( err ) { cprintf( "range value error\r\n");
           wait_for(3);exit( 1); }
        }
 else if ( !strcmp( tag_id, "DOF-OB"))
        {
        err= taggbi( tag_id, &os_bin);
        if ( err ) { cprintf( "tag error\r\n");  wait_for(3);exit( 1); }
        }
 else if ( !strcmp( tag_id, "DOF-OG"))
        {
        err= taggbi( tag_id, &os_gate);
        if ( err ) { cprintf( "tag error\r\n");  wait_for(3);exit( 1); }
        }
 else if ( !strcmp( tag_id, "DOD-FLAG"))
        {
```

```
            err= taggbi( tag_id, &os_meter);
            if ( err ) { cprintf( "tag error\r\n");  wait_for(3);exit( 1); }
            }
    else ;
}

/*** reads from the FIX database
***/
double read_FIX ( GBI tag_gbi )
{
int         ival;
char *err, tag_id[20];

    err = gbitag (tag_id, &tag_gbi);

    if ( !strcmp( tag_id, "AIF-OB" )) {
                    err= dbagcv( &os_bin_weight, &ival);
                    return ( cve( hi_bin_weight, lo_bin_weight, ival) );
                    }
    else if ( !strcmp( tag_id, "AOD-OBAT" )) {
                    err= dbagcv( &sp_os_bin_weight, &ival);
                    return ( cve( hi_sp_bin_weight, lo_sp_bin_weight, ival) );
                    }
    else if ( !strcmp( tag_id, "DOD-FLAG" )) {
                    err = dbagcv ( &os_meter, &ival);
                    return ( ival );
                    }
    else ;
}
```

```
        err= taggbi( tag_id, &os_meter);
        if ( err ) { cprintf( "tag error\r\n");  wait_for(3);exit( 1); }
        }
   else ;
}

/*** reads from the FIX database
***/
double read_FIX ( GBI tag_gbi )
{
int      ival;
char *err, tag_id[20];

   err = gbitag (tag_id, &tag_gbi);

   if ( !strcmp( tag_id, "AIF-OB" )) {
                err= dbagcv( &os_bin_weight, &ival);
                return ( cve( hi_bin_weight, lo_bin_weight, ival) );
                }
   else if ( !strcmp( tag_id, "AOD-OBAT" )) {
                err= dbagcv( &sp_os_bin_weight, &ival);
                return ( cve( hi_sp_bin_weight, lo_sp_bin_weight, ival) );
                }
   else if ( !strcmp( tag_id, "DOD-FLAG" )) {
                err = dbagcv ( &os_meter, &ival);
                return ( ival );
                }
   else ;
}

/***     writes to FIX database
***/
void write_FIX ( GBI tag_gbi, double value )
{
int ival;
char *err, tag_id[20];

   err = gbitag (tag_id, &tag_gbi);

   if ( !strcmp( tag_id, "DOF-OG" )) {
          ival = (int) value;
          err= dbapcv( &os_gate, ival);
          }
   else if ( !strcmp ( tag_id, "DOF-OB")){
                ival = (int) value;
                err= dbapcv( &os_bin, ival);
                }
   else if ( !strcmp ( tag_id, "AID-OS")){
                ival= cvi( hi_os_flowrate, lo_os_flowrate, value);
                err= dbapcv( &os_flowrate, ival);
                }
}

/***     reads the current system time
```

```
***/
float time_now ( float *c_time )
{
struct dostime_t ti_time;

        _dos_gettime ( &ti_time );
        *c_time = ti_time.hour * (float) 3600.0 ;
        *c_time += ti_time.minute * 60.0 ;
        *c_time += ti_time.second ;
        *c_time += ti_time.hsecond / 100.0 ;
        return (*c_time);
}

/***    waits for certain specified time
***/
void wait_for ( double t_time )
{

int sleep_time;

                sleep_time = (int) t_time*100 ;
                if ( sleep_time > 5 ) e_sleep( sleep_time );
                  return;
}
/*** test_exit(): checks for keyboard input. It exits program if
                  an <Y> is pressed or it exits and leaves it
                  running if <ALT X> is entered.
***/
int test_exit( void)
{
int msb, lsb;

if (kbhit())
  {
  msb = getch();
  msb = toupper(msb);
  if ((kbhit()) && (msb == 0))
    lsb = getch();
  else
    lsb = 0;
  while (kbhit()) getch();    /* clear keyboard buffer */
  if ((msb == 'Y') || (lsb == ALT_X))
    return(FALSE);
  else
    cprintf("<Alt x> exits with task active or 'y' exits\r\n");
  }
return(TRUE);
}
```

```
/*****************************************************************************
 *
 *                          " FFEED.C "
 *
 *       Main routine designed to measure and control the fresh feed
 *       flowrate to the mill. It interacts with the FIX database to
 *       read/write information.
 *
 *       Its operation is controlled by the flag "DOD-FLAG". When it is ON
 *       (equal 1), it calculates and controls the fresh feed. When it is
 *       OFF (equal 0), it is on an idle state
 *
*****************************************************************************/

#include <stdlib.h>
#include <stdio.h>
#include <string.h>
#include <conio.h>
#include <dos.h>

/***     includes the headers FIX needs in order to run
***/
#include "fixuser.h"
#include "dbafpt.h"
#include "exelib.h"

/***     defines the value of text used in the program
***/
#define ALT_X  0x2D
#define CLOSE_BIN 0
#define OPEN_BIN 1
#define ON 1
#define OFF 0
#define TRUE 1
#define FALSE 0

/*****************************************************************************
Specification of the different functions and variables used in the program.

  FUNCTIONS:
        test_exit: It gives the user the alternative of EXIT and
                        END the execution of the main program (ffeed.c) -
                        <y>; or to go to the FIX main menu and leave
                        the program running - <ALT-X>.

        read_FIX        : Reads the specified point in the FIX database.

        write_FIX       : Writes information to an specific point in the
                          FIX database.
        wait_for: Waits for a specific time (in seconds).
        time_now        : Reads the current system time.
        check_version   : Checks for the proper FIX version.
```

```
        Check_dbase     : Checks for the initialization of the FIX database.

        check_tag_range : Checks for errors on the tags and range of the
                          different points in the FIX database. Matches
                          tag names and GBI variables used in this program.

    VARIABLES:
                GBI     : Global block information. A structure that contains
                          the block type and block number.
*****************************************************************************/

int     test_exit( void);
double  read_FIX (GBI ff );
void    write_FIX (GBI ff, double x);
void    wait_for ( double x);
double  time_now (double *x);
void    main (void);
void    check_version(void);
void    check_dbase(void);
void    check_tag_range (char tag[20]);

char    *err, tag[20];
GBI     ff_bin_weight, sp_ff_flowrate, ff_meter, ff_vib_feeder, ff_bin_gate;
GBI     ff_alarm, ff_flowrate, total_ffeed, print_report;

double  net_weight [10], last_net_weight,  net_weight_accum, total_fresh_feed;
double  gross_weight, empty_weight, weight, batch_weight, sp_batch;
double  batch_weight_x;
double  flowrate, sp_flowrate, MAX_sp_flowrate, MAX_batch_weight ;
double  time_gone, initial_time, last_time, period, time_left;
double  time_interval [10], time_accum, status;

float   lo_ff_bin, hi_ff_bin, lo_ff_flowrate, hi_ff_flowrate ;
float   lo_sp_ff, hi_sp_ff, lo_total_ffeed, hi_total_ffeed;

int     fmt, batch_i, ff_state, number, number_batches;

/***    MAIN routine
***/
void main()
{
int idx, i;
/***     check version and FIX database initialization
***/
        check_version ();
        check_dbase ();

/***    check the tags and engineering. units in the FIX database
***/
        check_tag_range ("AIF-FB");
        check_tag_range ("AID-FF");
        check_tag_range ("AOD-TFF");
        check_tag_range ("PI-WM");
        check_tag_range ("DOF-VF");
```

```
        check_tag_range ("DOF-FB");
        check_tag_range ("DOD-FF-AL");
        check_tag_range ("DOD-FLAG");

/***    initializes the fresh feed totalizer
***/
        total_fresh_feed = 0;

/***    Maximum set point for the fresh feed flowrate
***/
        MAX_sp_flowrate = 2400;

/***    Maximum batch weight allowed for the fresh feed bin
***/
        MAX_batch_weight = 400;

/***    number of batch weights used to calculate the mean
       value for the fresh feed flowrate
***/
        number_batches = 6;

/***    Initial value of the FLAG that controls the sequence of
       steps concerning the measurement and control of the
       fresh feed flowrate.
***/
        ff_state = 99;

/***    Continues the execution unless a <y> is entered by the user
***/
  while ( test_exit()      )
  {

/***    Selects the specific task in the measurement and
       control of the fresh feed
***/
  switch ( ff_state )
  {
  case 1:
        initial_time = last_time;

/***    reads the set point for the fresh feed flowrate. If it is zero
       goes to an idle state where does not activates the feeder
       nor the bin door, and sets the flowrate to zero. If it is not
       zero, continues with the activities of measuring and controlling
       the flowrate.
***/
        sp_flowrate = read_FIX ( sp_ff_flowrate );

       if( sp_flowrate == 0 )
       {
       ff_state = 99;
       break;
       }
        if ( sp_flowrate > MAX_sp_flowrate )
```

```
                {
                sp_flowrate = MAX_sp_flowrate ;
                write_FIX ( sp_ff_flowrate, sp_flowrate);
                }

/***     sets the setpoint for the batch weight and
        the period of time between batches.
***/
          sp_batch = sp_flowrate/6;
          period = 10;                  /* seconds */

/***     determines the next batch weight in the bin
***/
          batch_weight = sp_batch + ( batch_weight - last_net_weight );

/***     limits the batch weight that is going to ask for
***/
          if ( batch_weight         < 1   ) {
                batch_weight_x = 0;}
          else if ( batch_weight   > MAX_batch_weight ){
                batch_weight_x = MAX_batch_weight ;}
          else
                batch_weight_x = batch_weight;

          gross_weight = batch_weight_x + empty_weight;


/***     fresh food goes into the bin. It waits until it reaches the batch
        weight specified and then it stops the feeder. If the maximum
        waiting time is reached before the batch weight is also stop the
        feeder and set an alarm ("DOD-FF-AL")
***/
          if ( batch_weight_x > 0 ) write_FIX ( ff_vib_feeder, ON);

cprintf (" \r\n SP_batch_weight:  %f \r\n",sp_batch);
cprintf ("  batch_weight:  %f \r\n",batch_weight);
cprintf ("   empty_weight:  %f \r\n",empty_weight);

                time_gone = 0;    weight = 0;
                while ( time_gone < period - 6.0 )

/***     '6.0' it is the total time spent before filling the bin
***/
                {
                if ( weight < (gross_weight ) )
                  {
                  wait_for (0.1);
                  weight = read_FIX ( ff_bin_weight );

/*** cprintf (" weight:  %f \r",weight);
***/
                  }
                else {
                  write_FIX ( ff_alarm, OFF );
```

```
                ff_state= 2;    break; }

/***     calculates the time passed by since the last batch
***/
                time_gone = time_now (&last_time) - initial_time ;
                }
            write_FIX ( ff_alarm, ON );

  case 2:

/***     measures the gross weight of the bin
***/
            write_FIX ( ff_vib_feeder, OFF );
                wait_for (2);
            gross_weight= read_FIX ( ff_bin_weight ) ;

/***     measures the weight of the empty bin
***/
            write_FIX ( ff_bin_gate, OPEN_BIN );
                wait_for (1);
            write_FIX ( ff_bin_gate, CLOSE_BIN );
                wait_for (3.0);
            empty_weight = read_FIX ( ff_bin_weight ) ;

/*** calculates the "net weight" of the ore in the bin
***/
            net_weight [batch_i] = gross_weight - empty_weight;

            if ( net_weight[batch_i] < 0 ) net_weight[batch_i] = 0;
            last_net_weight = net_weight[batch_i];

cprintf ("\r\n              net weight:  %f \r\n",last_net_weight);

/***     adds the net weight to the fresh feed totalizer
***/
                total_fresh_feed = read_FIX ( total_ffeed);

                total_fresh_feed += last_net_weight/1000;
                write_FIX ( total_ffeed, total_fresh_feed );

/***     checks if there is any time left in the batch time
***/
            time_gone = time_now (&last_time) - initial_time;
            time_left = period - time_gone;

/***     waits for the time left, if any. The variable "last_time" takes
        the last reading of the system time
***/
            if ( time_left > (float) 0.05 )
              {
              wait_for (time_left);
              time_interval [batch_i] = time_now (&last_time) - initial_time;
              }
```

```
            else
              time_interval [batch_i] = time_gone;

/***     calculates the flowrate of fresh food in grams per minute as the
        mean value of the last "number" batch weights; where "number"
        is set to one at the beginning of this algorithm and every time
        that the fresh food flowrate is set to zero.
***/
            if ( ++number > number_baches ) number = number_baches;

            net_weight_accum = 0;          time_accum = 0;
            for ( idx = 1 ; idx <= number; idx++)
            {
            net_weight_accum += net_weight [idx];
                time_accum += time_interval [idx];
            }

           flowrate = 60 * net_weight_accum / time_accum;

cprintf (" \r\n    flowrate: %f \r\n" ,flowrate);

/***    sends back to the FIX the flowrate calculated
***/
             write_FIX ( ff_flowrate, flowrate );

/***    sets the index for the next batch weight
***/
            if( ++batch_i > number_baches ) batch_i = 1;

            ff_state = 1;

/***    checks for the flag (DOD-FLAG) that allows the measurement and
        control of the fresh feed to work
***/
                 status = read_FIX ( ff_motor );

                 if ( status == OFF )
                 {
                 ff_state = 99;       wait_for(10);
                 }
           break;

  case 99:

/***    checks for the flag that allows the measurement and control of the
        fresh feed to work
***/
                 status =  read_FIX ( ff_motor );

                 if ( status == OFF )
                 {
                 cprintf( "waiting for DOD_FLAG ....\r\n" );

                 write_FIX ( ff_vib_feeder, OFF);
```

```
                wait_for(10);
                break;
                }
/***    if the flag is ON (1), it checks for the flowrate setpoint.
       If this setpoint is zero, sets the fresh food flowrate to zero
       in the FIX database.
***/
       sp_flowrate = read_FIX ( sp_ff_flowrate );

       if( sp_flowrate == 0 )
       {
          flowrate = 0;
          write_FIX ( ff_flowrate, flowrate );
          wait_for(10);
          break;
       }
/***    if the set point of the fresh food flowrate is not zero,
       it initializes some variables
***/
          batch_i= 1; number = 0;
          batch_weight = 0 ;        last_net_weight = 0 ;
          for (i=1; i <= number_batches; i++) {
                time_interval[i] = 0; net_weight[i]= 0;}

/***    measures the weight of the empty bin
***/
          write_FIX ( ff_vib_feeder, OFF);
          write_FIX ( ff_bin_gate, OPEN_BIN);
                wait_for (2.5);
          write_FIX ( ff_bin_gate, CLOSE_BIN);
                wait_for (4);

          empty_weight = read_FIX ( ff_bin_weight );

/***    sets the initial time for the batch weight
***/
          initial_time = time_now ( &last_time );

          ff_state= 1;

   } /* end of switch */
   } /* end of while */

} /* end of main */
/*****************************************************************************/

/*** checks version and database initialization
***/
void check_versions()
{
        if (!e_vers()) {   cprintf("vers error \r\n");
          wait_for(3);exit( 1);
        }
}
```

```
void check_dbase()
{
        err = dbainit();
        if ( err ) { cprintf( "init error \r\n");
          wait_for(3);exit( 1);
        }
}

/*** checks the TAG and the RANGE of different points in the FIX database
***/
void check_tag_range (char tag_id[20])
{
  if ( !strcmp( tag_id, "AIF-FB") )
        {
        err= taggbi( tag_id, &ff_bin_weight);
        if ( err ) { cprintf( "tag1 error\r\n"); exit( 1); }
                err= dbagcve( &ff_bin_weight, &lo_ff_bin, &hi_ff_bin, &fmt);
        if ( err ) { cprintf( "range value error\r\n"); exit( 1); }
        }
  else if ( !strcmp( tag_id, "AID-FF") )
        {
        err= taggbi( tag_id, &ff_flowrate);
        if ( err ) { cprintf( "tag2 error\r\n"); exit( 1); }
        err= dbagcve( &ff_flowrate, &lo_ff_flowrate, &hi_ff_flowrate, &fmt);
        if ( err ) { cprintf( "range value error\r\n"); exit( 1); }
        }
  else if ( !strcmp( tag_id, "AOD-TFF") )
        {
        err= taggbi( tag_id, &total_ffeed);
        if ( err ) { cprintf( "tag2 error\r\n"); exit( 1); }
        err= dbagcve( &total_ffeed, &lo_total_ffeed, &hi_total_ffeed, &fmt);
        if ( err ) { cprintf( "range value error\r\n"); exit( 1); }
        }
  else if ( !strcmp( tag_id, "PI-WM") )
        {
        err= taggbi( tag_id, &sp_ff_flowrate);
        if ( err ) { cprintf( "tag error\r\n"); exit( 1); }
        err= dbagcve( &sp_ff_flowrate, &lo_sp_ff, &hi_sp_ff, &fmt);
        if ( err ) { cprintf( "range value error\r\n"); exit( 1); }
        }
  else if ( !strcmp( tag_id, "DOF-VF") )
        {
        err= taggbi( tag_id, &ff_vib_feeder);
        if ( err ) { cprintf( "tag error\r\n"); exit( 1); }
        }
  else if ( !strcmp( tag_id, "DOF-FB") )
        {
        err= taggbi( tag_id, &ff_bin_gate);
        if ( err ) { cprintf( "tag error\r\n"); exit( 1); }
        }
  else if ( !strcmp( tag_id, "DOD-FF-AL") )
        {
        err= taggbi( tag_id, &ff_alarm);
        if ( err ) { cprintf( "tag error\r\n"); exit( 1); }
```

```
        }
  else if ( !strcmp( tag_id, "DOD-FLAG") )
        {
        err= taggbi( tag_id, &ff_meter);
        if ( err ) { cprintf( "tag error\r\n"); exit( 1); }
        }
}

/***                reading from the FIX database
***/
double read_FIX ( GBI tag_gbi )
{
int       ival;
char tag_id[20];

/***      converts the GBI variables into string characters
***/
  err = gbitag (tag_id, &tag_gbi);

  if ( !strcmp( tag_id, "AIF-FB" )) {
        err= dbagcv( &ff_bin_weight, &ival);
        return ( cve( hi_ff_bin, lo_ff_bin, ival) );
        }
  else if ( !strcmp( tag_id, "AOD-TFF")) {
        err= dbagcv( &total_ffeed, &ival);
        return ( cve( hi_total_ffeed, lo_total_ffeed, ival) );
        }
  else if ( !strcmp( tag_id, "FI-WM" )) {
        err= dbagcv( &sp_ff_flowrate, &ival);
      return ( cve( hi_sp_ff, lo_sp_ff, ival) );
        }
  else if ( !strcmp( tag_id, "DOD-FLAG" )) {
        err = dbagcv ( &ff_meter, &ival);
        return ( ival );
        }
}

/***      writing  to FIX database
***/
void write_FIX ( GBI tag_gbi, double value )
{
int ival;
char tag_id[20];

/***      converts GBI variables into string characters
***/
  err = gbitag (tag_id, &tag_gbi);

  if ( !strcmp( tag_id, "AID-FF" )) {
        ival = cvi(hi_ff_flowrate, lo_ff_flowrate, value );
        err = dbagcv (&ff_flowrate, ival);
        }
  if ( !strcmp( tag_id, "AOD-TFF" )) {
        ival = cvi(hi_total_ffeed, lo_total_ffeed, value );
```

```
                    err = dbapcv (&total_feed, ival);
                    }
    else if ( !strcmp( tag_id, "DOD-FF-AL" )) {
                    ival = (int) value;
            err = dbapcv (&ff_alarm, ival );
                    }
    else if ( !strcmp( tag_id, "DOF-FB" )) {
                    ival = (int) value ;
                    err= dbapcv( &ff_bin_gate, ival );
                    }
    else if ( !strcmp( tag_id, "DOF-VF" )) {
                    ival = (int) value ;
            err= dbapcv( &ff_vib_feeder, ival );
                    }
} /* end of write */

/***   reads the current system time from the clock (in seconds).
       Returns the time and assigns it to the argument variable
***/
double time_now ( double *c_time )
{
struct dostime_t ti_time;

        _dos_gettime ( &ti_time );
        *c_time =  ti_time.hour * 3600.0 ;
        *c_time += ti_time.minute * 60.0 ;
        *c_time += ti_time.second ;
        *c_time += ti_time.hsecond / 100.0 ;
        return (*c_time);
}

/***     waits for certain specified time. It uses the e_sleep
        function provided by FIX
***/
void wait_for ( double t_time )
{
int sleep_time;

        sleep_time = (int) t_time*100 ;
        if ( sleep_time > 5 ) e_sleep( sleep_time );
        return;
}

/*** test_exit(): checks for keyboard input. Exits the program
                    if <Y> was pressed, or exits and leaves it
                    running when <ALT X> is entered.
***/
int test_exit( void)
{
int msb, lsb;

  if (kbhit())
  {
    msb = getch();
```

```
    msb = toupper(msb);
          if ((kbhit()) && (msb == 0))
          lsb = getch();
          else
          lsb = 0;

    while (kbhit())       getch();    /* clear keyboard buffer */
          if ((msb == 'Y') || (lsb == ALT_X))
          return(FALSE);
          else
          cprintf("<Alt x> exits with task active or 'y' exits\r\n");
  }
  return(TRUE);
}
/*****************************************************************************/
```

```
/*****************************************************************************
*
*                        " OSIZE.C "
*
*
*       OS.C is a routine designed to measure the oversize flowrate
*       returning to the mill. It measures batch weights on the oversize
*       bin and the time between measurements to calculate the flowrate.
*       The value reported is the mean value of the last four measurements.
*
*       When the flag "DOD-FLAG" is OFF (equal 0), the routine goes to
*       an idle state.
*****************************************************************************/

#include <stdlib.h>
#include <stdio.h>
#include <string.h>
#include <conio.h>
#include <dos.h>

/***     includes the headers that FIX needs in order to run
***/
#include "fixuser.h"
#include "dbalpt.h"
#include "exelib.h"

/***     defines the value of TEXT used in the program
***/
#define ALT_X  0x2D
#define TRUE   1
#define FALSE  0
#define CLOSE 1
#define OPEN 0
#define CLOSE_DOOR 0
#define OPEN_DOOR 1
#define OFF 0
#define ON 1

/***
Specification of the different functions and variables used in the program.

  FUNCTIONS:
        test_exit: It gives the user the alternative of EXIT and
                        END the execution of the main program (noise.e) -
                        <y>; or to go to the FIX main menu and leave
                        the program running - <ALT-X>.

        read_FIX        : Reads the specified point in the FIX database.

        write_FIX       : Writes information to an specific point in the
                        FIX database.
        wait_for : Waits for a specific time (in seconds).
        time_now        : Reads the current system time.
```

```
        check_version    : Checks for the proper FIX version.

        check_dbase      : Checks for the initialization of the FIX database.
        check_tag_range  : Checks for errors on the tags and range of the
                           different points in the FIX database. Matches
                           tag names and GBI variables used in this program.

    VARIABLES:
                GBI      : Global block information. A structure that contains
                           the block type and block number.

**********************************************************************************/

void main(void);
int test_exit( void);
void check_version(void);
void check_dbase(void);
void check_tag_range (char tag[20]);
double read_FIX ( GBI ff);
void write_FIX (GBI ff, double f);
void wait_for (double f);
float time_now (float *f);

GBI     os_bin_weight, os_flowrate, sp_os_bin_weight ;
GBI     os_gate,os_bin, os_meter;

double  bin_weight, gross_weight, empty_weight, net_weight [10];
double  net_weight_accum, sp_bin_weight, bin_batch_weight, flowrate, status;
double  last_batch_time;

float   lo_bin_weight, hi_bin_weight, lo_os_flowrate, hi_os_flowrate;
float   lo_sp_bin_weight, hi_sp_bin_weight;
float   time_interval[10], initial_time, time_accum, last_time, time_gone;
float   max_batch_time;
char *err;
int fini, number_batches;

/***    MAIN routine
***/
void main()
{
int     i, batch_i, os_state;

/***    checks the version and the initialization of the FIX database
***/
        check_version();
        check_dbase();

/***    checks errors in the tag name and range of the different
        points of the FIX database used in the program
***/
        check_tag_range ("AIP-OB");
        check_tag_range ("AID-OS");
        check_tag_range ("AOD-OBAT");
```

```
        check_tag_range ("DOF-OB");
        check_tag_range ("DOF-OC");
        check_tag_range ("DOD-FLAG");

/***    defines the number of batch weight it is going to use
        to calculate the flowrate.
***/
        number_batches = 4;

/***    defines the maximum time it will wait to reach the gross bin
        weight specified by the user
***/
        max_batch_time = 40 ;    /* (seconds) */

/***    the initial state of the oversize flowmeter is idle (os_state=99)
        It waits until the flag (DOD-FLAG) is set to one (ON).
***/
        os_state= 99;

/***    checks for keyboard input. If a <y> is entered it exits the program.
        <ALT X> leaves the program running and returns to the FIX main menu.
***/
  while ( test_exit() ) {

/***    selects the specific activities to be performed according to the
        value of os_state
***/
        switch( os_state)
        {
        case 1:                  /* wait for oversize bin to be filled */

/***    reads the maximum batch weight specified by the user, and
        determines the gross bin weight it has to wait for
***/
                sp_bin_weight = read_FIX ( sp_os_bin_weight );
                bin_batch_weight = sp_bin_weight + empty_weight;

                  write_FIX ( os_gate, OPEN);

/***    goes to sleep for 80 % of time associated with the last batch time
***/
          wait_for ( last_batch_time * 0.80 );

/***    waits until the specified gross weight or until the maximum batch
        time is reached. Then it proceeds to measured the bin weights.
***/
                time_gone = 0 ;
                while ( time_gone < max_batch_time -4 )

/***  'i' is the accumulated idle time on 'wait_for' functions on each cycle
***/
                {
                bin_weight = read_FIX ( os_bin_weight );
                if ( bin_weight < bin_batch_weight ) {
```

```
                wait_for (0.5);
                }
              else {
                os_state = 2;  break;}

              time_gone = time_now (&last_time) - initial_time;
              }
        case 2:

/***   after the batch weight or the maximum time has been reached,
      the gate is closed and the bin weight is measured
***/
              write_FIX ( os_gate, CLOSE);
              wait_for (2);

/***   measures the gross weight of the bin
***/
              gross_weight = read_FIX ( os_bin_weight);

              write_FIX ( os_bin, OPEN_DOOR);
              wait_for (1);
              write_FIX (os_bin, CLOSE_DOOR);
              wait_for (3);

/***   measures the empty weight of the bin and calculates the net weight
***/
              empty_weight = read_FIX ( os_bin_weight );

              net_weight [ batch_i] = gross_weight - empty_weight;

/***   calculates the time interval associated with the last batch weight
***/
          time_interval [batch_i] = time_now (&last_time) - initial_time;
              initial_time = last_time;
              last_batch_time = time_interval [batch_i];

              if ( ++batch_i > number_batches ) batch_i = 1;

/***   calculates the oversize flowrate in grams per minute, as the mean
      value of the last four measurements
***/
                net_weight_accum = 0;  time_accum = 0;
                    for ( i = 1; i <= number_batches; i++ ) {
                    net_weight_accum  += net_weight [ i];
                    time_accum += time_interval [ i];
                    }
              flowrate = 60.0 * net_weight_accum / time_accum;

/***   writes the calculated flowrate back to the FIX database
***/
              write_FIX ( os_flowrate, flowrate);
              os_state = 1;

/***   checks for the status of the flag (DOO-FLAG) that activates the
```

```
        flowrate measurement. If it is OFF it goes to an idle state until
        it is set ON
***/
                status = read_FIX ( os_meter );
                if ( status == OFF )
                {
                os_state = 99 ;   wait_for(10);
                }
              break;

        case 99:

/***     Idling state: waiting for the flag DOD-FLAG to be ON to start.
        It checks the flag every 10 sec.
        It opens the gate and door of the bin.
***/
                status = read_FIX ( os_meter );
                if ( status == OFF )
                {
                cprintf( "waiting for DOD-FLAG ....\r\n" );
                write_FIX ( os_gate, OPEN);
                write_FIX ( os_bin, OPEN_DOOR);
                wait_for (10);
                break;
                }

/***     when the flag DOD-FLAG is ON (equal 1) it initializes some
        variables
***/
              batch_i = 1 ;
            for (i=1; i <= number_batches; i++)
                { time_interval[i] = 0; set_weight[i]= 0;}

                write_FIX ( os_gate, CLOSE);
                write_FIX ( os_bin, OPEN_DOOR);
                  wait_for (2);
                write_FIX (os_bin, CLOSE_DOOR);
                  wait_for (3);
                empty_weight = read_FIX ( os_bin_weight );

                initial_time = time_now ( &last_time );
                os_state = 1;

        }  /* end of switch */
    }     /* end of while */
}  /* end of main */
/*****************************************************************************/

/*** checks version and database initialization
***/
void check_version()
{
        if (!os_vers()) {   cprintf("vers error\r\n");
          wait_for(3);exit( 1);
```

```
        }
}

void check_dbase()
{
char *err;

        err = dbinit();
        if ( err ) { cprintf( "ora error\r\n");
          wait_for(3);exit( 1);
          }
}

/*** checks the TAG and the RANGE in the FIX database
***/
void check_tag_range (char tag_id[20])
{
  if ( !strcmp( tag_id, "AIF-OB"))
        {
        err= taggbi( tag_id, &os_bin_weight);
        if ( err ) { cprintf( "tag error\r\n");  wait_for(3);exit( 1); }
        err= dbagcve( &os_bin_weight, &lo_bin_weight, &hi_bin_weight, &fmt);

        if ( err ) { cprintf( "range value error\r\n");
          wait_for(3);exit( 1); }
        }
  else if ( !strcmp( tag_id, "AID-OS"))
        {
        err= taggbi( tag_id, &os_flowrate);
        if ( err ) { cprintf( "tag error\r\n");  wait_for(3);exit( 1); }
        err= dbagcve( &os_flowrate, &lo_os_flowrate, &hi_os_flowrate, &fmt);
        if ( err ) { cprintf( "range value error\r\n");
          wait_for(3);exit( 1); }
        }
  else if ( !strcmp( tag_id, "AOD-OBAT"))
        {
        err= taggbi( tag_id, &sp_os_bin_weight);
        if ( err ) { cprintf( "tag error\r\n");  wait_for(3);exit( 1); }
        err= dbagcve( &sp_os_bin_weight, &lo_sp_bin_weight, &hi_sp_bin_weight, &fmt);
        if ( err ) { cprintf( "range value error\r\n");
          wait_for(3);exit( 1); }
        }
  else if ( !strcmp( tag_id, "DOF-OB"))
        {
        err= taggbi( tag_id, &os_bin);
        if ( err ) { cprintf( "tag error\r\n");  wait_for(3);exit( 1); }
        }
  else if ( !strcmp( tag_id, "DOF-OD"))
        {
        err= taggbi( tag_id, &os_gate);
        if ( err ) { cprintf( "tag error\r\n");  wait_for(3);exit( 1); }
        }
  else if ( !strcmp( tag_id, "DOD-FLAG"))
        {
```

```
        err= ggghi( tag_id, &os_mean);
        if ( err ) { cprintf( "tag error\n");  wait_for(3);exit( 1); }
        }
    else ;
}

/*** reads from the FIX database
***/
double read_FIX ( GBI tag_ghi )
{
int     ival;
char *err, tag_id[20];

    err = ghiag (tag_id, &tag_ghi);

    if ( !strcmp( tag_id, "AIF-OB" )) {
                err= dhgcv( &os_bin_weight, &ival);
                return ( cvt( hi_bin_weight, lo_bin_weight, ival) );
                }
    else if ( !strcmp( tag_id, "AOD-OBAT" )) {
                err= dhgcv( &sp_os_bin_weight, &ival);
                return ( cvt( hi_sp_bin_weight, lo_sp_bin_weight, ival) );
                }
    else if ( !strcmp( tag_id, "DOD-FLAG" )) {
                err = dhgcv ( &os_mean, &ival);
                return ( ival );
                }
    else ;
}

/***     writes to FIX database
***/
void write_FIX ( GBI tag_ghi, double value )
{
int ival;
char *err, tag_id[20];

    err = ghiag (tag_id, &tag_ghi);

    if ( !strcmp( tag_id, "DOF-OD" )) {
            ival = (int) value;
            err= dhgcv( &os_gain, ival);
            }
    else if ( !strcmp ( tag_id, "DOF-OB")){
                ival = (int) value;
                err= dhgcv( &os_bin, ival);
                }
    else if ( !strcmp ( tag_id, "AID-OI")){
                ival= cvt( hi_os_flowmax, lo_os_flowmax, value);
                err= dhgcv( &os_flowmax, ival);
                }
}

/***     reads the current system time
```

```
***/
float time_now ( float *c_time )
{
struct dostime_t ti_time;

        _dos_gettime ( &ti_time );
        *c_time = ti_time.hour * (float) 3600.0 ;
        *c_time += ti_time.minute * 60.0 ;
        *c_time += ti_time.second ;
        *c_time += ti_time.hsecond / 100.0 ;
        return (*c_time);
}

/***    waits for certain specified time
***/
void wait_for ( double t_time )
{

int sleep_time;

                sleep_time = (int) t_time*100 ;
                if ( sleep_time > 5 ) s_sleep( sleep_time );
                   return;
}
/*** test_exit(): checks for keyboard input. It exits program if
                  an <Y> is pressed or it exits and leaves it
                  running if <ALT X> is entered.
***/
int test_exit( void)
{
int mab, lab;

if (kbhit())
  {
  mab = getch();
  mab = toupper(mab);
  if ((kbhit()) && (mab == 0))
    lab = getch();
  else
    lab = 0;
  while (kbhit()) getch();    /* clear keyboard buffer */
  if ((mab == 'Y') || (lab == ALT_X))
    return(FALSE);
  else
    cprintf("<Alt z> exits with task active or 'y' exits\r\n");
  }
return(TRUE);
}
```

Appendix B:
Displays and Key Macros

Background:
The man machine interface is provided by displays and menus viewed on the computer monitor. During the normal running of the mill only the displays are needed. They provide easy detailed access to information and control of the circuit. The links between the displays are shown below in figure 19. A single keystroke, (F-key), is used to move between displays. The circuit is controlled and data displayed by links from the database to these displays.

Figure B1. Links Between Displays Used to Control the 60cm SAG Mill Circuit at the University of British Columbia.

The displays and key macros (links) used in the 60cm SAG mill control system are shown in the following figures and tables. Help is always available by hitting the <F1> key. Along the bottom of all the displays are the <F keys> that move to other displays and initiate control actions. The current time and date are in the upper left corner. Most displays have an alarm window to the right of the time and date. The small bars along the top flash (one for each alarm) when an alarm is active. In addition the last alarm message is displayed in the small window in the upper right of the display.

The body of the display shows flows, weights, alarms, etc. depending on the purpose of the display. The values shown are real time values. Subpictures and links animate the displays. Control actions are initiated from the displays ie., starting, stopping, tuning the regulatory control loops, trending of flow rates, power, etc.

Startup Parameter Display:

Figure B2. Startup Parameter Display for the 60cm SAG Mill Circuit at the University of British Columbia.

Table B1. Key Macros for the Sensor Calibration Display Used in the 60cm SAG Mill Circuit at the University of British Columbia.

Key	Function
<F1>	HELP. Applies to all displays
<F2>	CONTINUE with startup. Enter the required setpoints before continuing.
<F8>	DISABLE AUDIO ALARMS. Invokes ALARM SUMMARY DISPLAY. To disable audio alarm press any key to continue, followed by <ALT><F8>. Then, press <F10> to return to the STARTUP Parameter display.
<ALT>A	ENTER SUMP LEVEL SETPOINT. Type the required value and press <ENTER>
<ALT>B	ENTER MILL WEIGHT SETPOINT. Type the required value and press <ENTER>
<ALT>C	ENTER MILL WATER RATIO. Type the required value and press <ENTER>
<ALT>D	ENTER OVERSIZE BIN BATCH WEIGHT. Type the required value and press <ENTER>
<ALT>E	ENTER MILL SPEED SETPOINT. Type the required value and press <ENTER>
<ALT>F	ENTER SAMPLE NAME. Type the sample name and press <ENTER>
<ALT>G	ENTER RUN NUMBER. Type the required value and press <ENTER>
<ALT>H	ENTER BALL LOAD. Type in the ball load weight and press <ENTER>
<ALT>I	ENTER DATE. Type in todays date (format is YYMMDD) and press <ENTER>

Sensor Calibration Display:

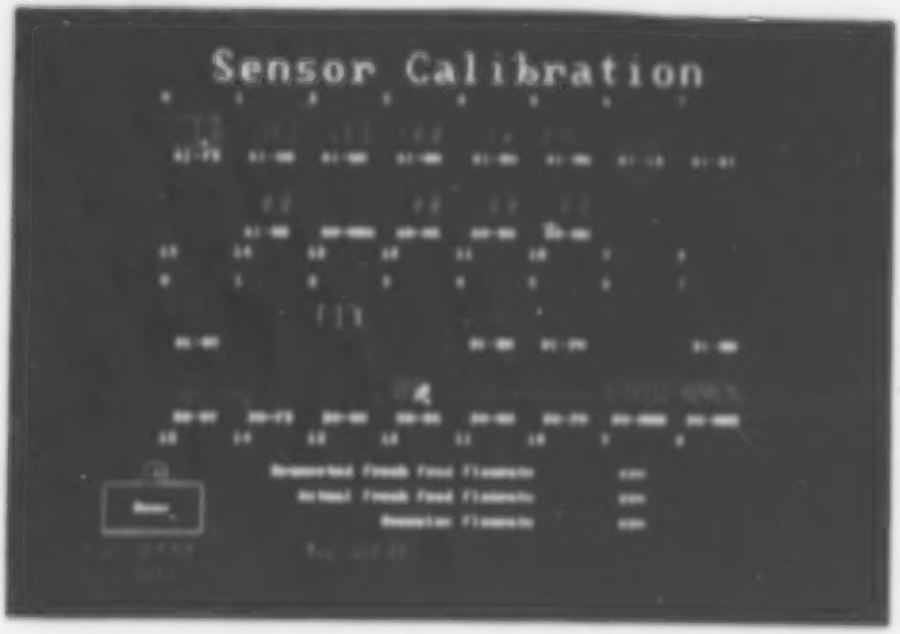


Figure B3. Sensor Calibration Display for the 60cm SAG MBE Circuit at the University of British Columbia.

Table B2. Key Macros for the Startup Parameter Display Used in the 60cm SAG MBE Circuit at the University of British Columbia.

Key	Function
<F1>	HELP. Applies to all displays
<F8>	DONE. Returns to the STARTUP Parameters display.

Manual or Automatic Startup Display:

Figure B4. Manual or Automatic Startup Display for the 68km SAG Mill Circuit at the University of British Columbia.

Table B3. Key Macros for the Manual or Automatic Startup Display Used in the 68km SAG Mill Circuit at the University of British Columbia.

Key	Function
<F1>	HELP. Applies to all displays
<F8>	STARTUP SEQUENCE. Initiates automatic startup of circuit.
<F9>	MANUAL STARTUP. Allows manual startup of circuit.

Process Overview Display:

Figure B5. Process Overview Display for the 60ton SAG Mill Circuit at the University of British Columbia.

Table B4. Key Macros for the Process Overview Display Used in the 60ton SAG Mill Circuit at the University of British Columbia.

Key	Function
<F1>	HELP. Applies to all displays.
<F3>	CONTROL Overview. Invokes the CONTROL Overview display.
<F4>	TRENDS Overview. Invokes the TRENDS Overview display.
<F5>	ALARM Report. Invokes the ALARM Report display.
<F8>	GENERATE REPORT. Causes printing of final report. Should be used at the end of a run before initiating the automated shutdown sequence. Note: The screen is blanked while the report is printed.
<F9>	SHUTDOWN Sequence. Initiates automatic shutdown of the circuit.
<CTRL>A	ACKNOWLEDGE ALARMS.
<CTRL>S	PLACE BLOCK OFF/ON SCAN. Select link to required input and press <CNTRL>S to toggle the block off and on scan.
<ALT>F	OPEN/CLOSE FRESH FEED BIN DOOR. Toggles door open and closed.
<ALT>O	OPEN/CLOSE OVERSIZE SLIDING GATE. Toggles gate open and closed.
<ALT>M	START/STOP MILL MOTOR. Toggles mill motor contactor open and closed.
<ALT>O	OPEN/CLOSE OVERSIZE BIN DOOR. Toggles door open and closed.
<ALT>P	START/STOP PUMP MOTOR. Toggles pump motor contactor open and closed.
<ALT>S	START/STOP SCREEN MOTOR. Toggles screen contactor open and closed.
<ALT>V	START/STOP VIBRATING FEEDER. Toggles feeder contactor open and closed.

Control Overview Display:

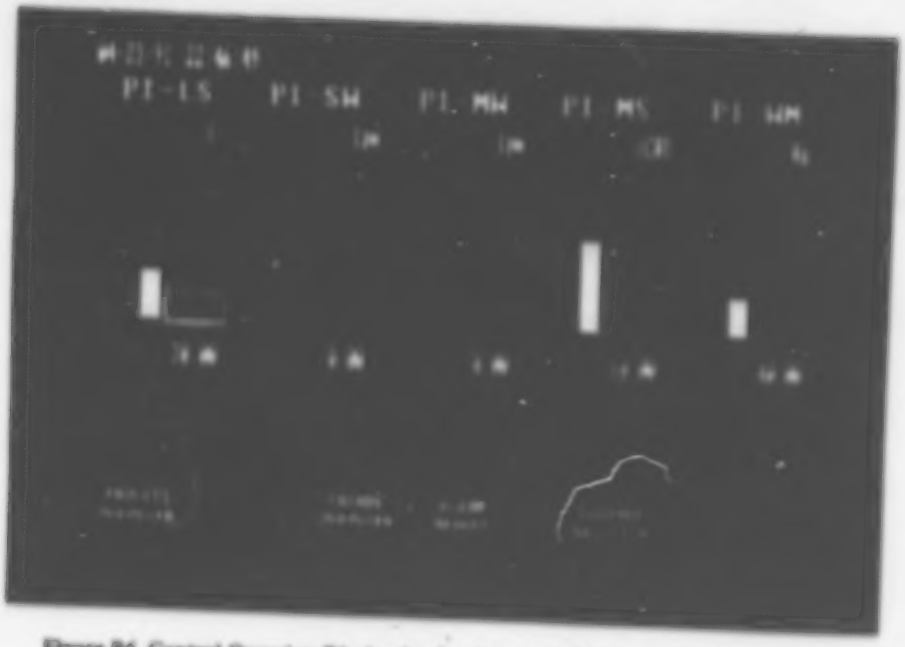


Figure B6. Control Overview Display for the 60cm SAG Mill Circuit at the University of British Columbia.

Table B5. Key Macros for the Control Overview Display Used in the 60cm SAG Mill Circuit at the University of British Columbia.

Key	Function
<F1>	HELP. Applies to all displays.
<F2>	PROCESS Overview. Invokes the PROCESS Overview display.
<F4>	TRENDS Overview. Invokes the TRENDS Overview display.
<F5>	ALARM Report. Invokes the ALARM Report display.
<F6>	CONTROL BY: FIX/FISHER. Toggles control of mill speed, mill water, sump water and sump level control loops between the FIX™ control software and the Fisher™ single loop controllers.
<CTRL>A	ACKNOWLEDGE ALARMS.
<CTRL>S	PLACE BLOCK OFF/ON SCAN. Select link to required input and press <CNTRL>S to toggle the block off and on scan.
<ALT>M	SELECT CONTROLLER AUTO/MANUAL MODE. Repeating keystroke will select the next controller. Type A<ENTER> for AUTO, M<ENTER> for MANUAL.
<ALT>O	SELECT CONTROLLER OUTPUT. Repeating keystroke will select the next controller. Type the required numerical value followed by <ENTER>.
<ALT>S	SELECT CONTROLLER SETPOINT. Repeating keystroke will select the next controller. Type the required numerical value followed by <ENTER>.
<ALT>T	SELECT CONTROLLER TREND. Repeating keystroke will select the next controller. <ENTER> invokes the controller's TREND display.

Trends Overview Displays:

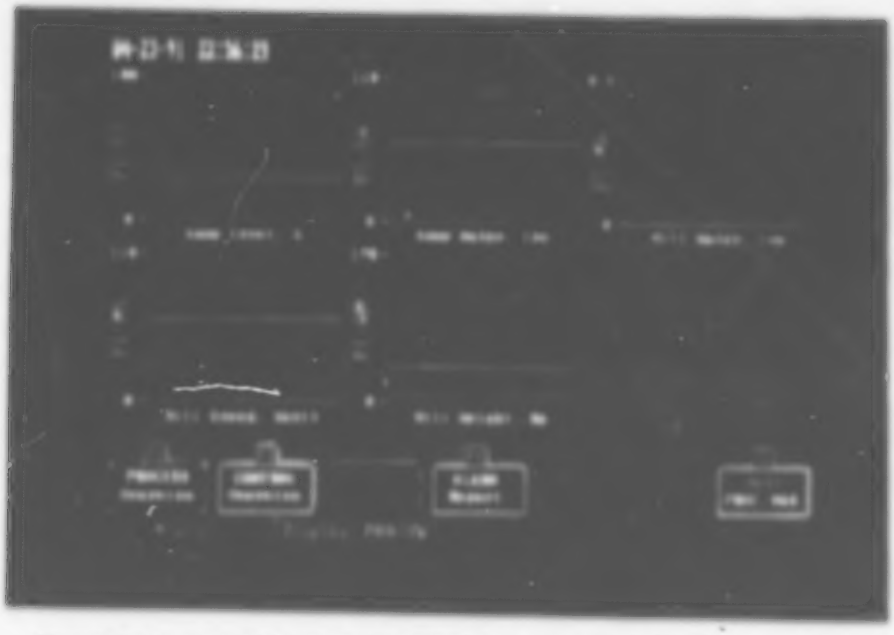


Figure B7. Controller Values(s) Trend Display for the 68rm SAG Mill Circuit at the University of British Columbia.

Table B6. Key Macros for the Controller Values Trend Display Used in the 68rm SAG Mill Circuit at the University of British Columbia.

Key	Function
<F1>	HELP. Applies to all displays
<F2>	PROCESS Overview. Invokes the PROCESS Overview display.
<F3>	CONTROL Overview. Invokes the CONTROL Overview display.
<F5>	ALARM Report. Invokes the ALARM Report display.
<F7>	NEXT PROC. VAR. Invokes the next trend display (process values).
<CTRL>A	ACKNOWLEDGE ALARMS

Figure 88. Process Value(s) Trend Display for the 48ton SAG Mill Circuit at the University of British Columbia.

Table 87. Key Macros for the Process Values Trend Display Used in the 48ton SAG Mill Circuit at the University of British Columbia.

Key	Function
<F1>	HELP. Applies to all displays.
<F2>	PROCESS Overview. Invokes the PROCESS Overview display.
<F3>	CONTROL Overview. Invokes the CONTROL Overview display.
<F5>	ALARM Report. Invokes the ALARM Report display.
<F7>	PREVIOUS CNTRL VAR. Invokes the previous trend display (controller values).
<CTRL>A	ACKNOWLEDGE ALARMS.

Alarm Report Display:

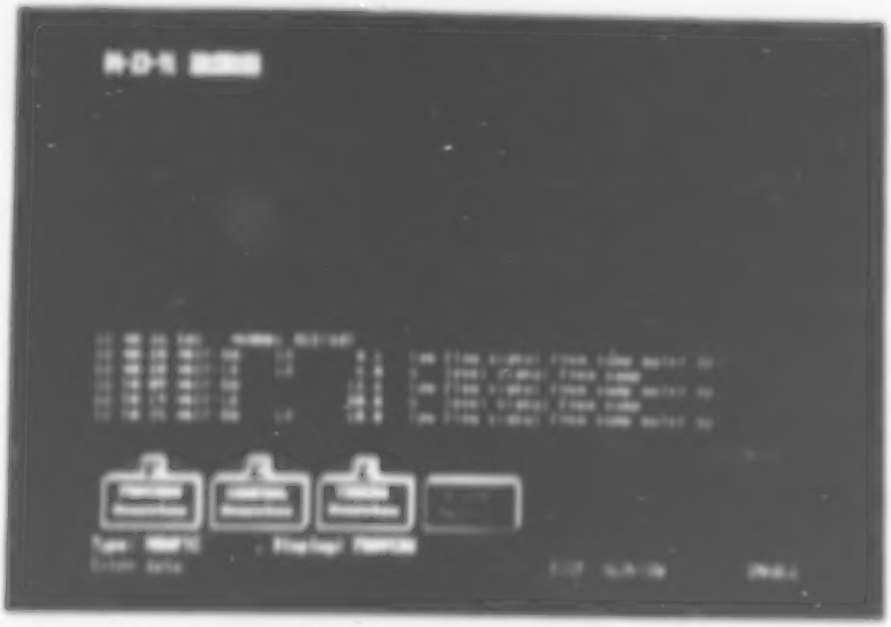


Figure B8. Alarm Report Display for the 60cm SAG Mill Circuit at the University of British Columbia.

Table B8. Key Macros for the Alarm Report Display Used in the 60cm SAG Mill Circuit at the University of British Columbia.

Key	Function
<F1>	HELP. Applies to all displays
<F2>	PROCESS Overview. Invokes the PROCESS Overview display
<F3>	CONTROL Overview. Invokes the CONTROL Overview display
<F4>	TRENDS Overview. Invokes the TRENDS Overview display
<CTRL>A	ACKNOWLEDGE ALARMS

Shutdown Sequence Display

Figure B10. Shutdown Sequence Display for the 60cm SAG 9GB Circuit at the University of British Columbia.

Table B9. Key Macros for the Shutdown Sequence Display Used in the 60cm SAG 9GB Circuit at the University of British Columbia.

Key	Function
<F1>	HELP. Applies to all displays
<F6>	ANOTHER Run. Invokes the AGAIN display, which contains instructions on preparing for another run.
<F9>	EXIT. Invokes the EXIT display, which contains instructions for the final circuit shutdown.

Another Run Display

Figure 8.11. Another Run Display for the 68kin SAG MSB Circuit at the University of British Columbia.

Table 8.10. Key Macros for Another Run Display Used in the 68kin SAG MSB Circuit at the University of British Columbia.

Key	Functions
<F1>	HELP. Applies to all displays.
<F2>	CONTINUE. Invokes the START display from which any changes to the circuit startup parameters for the next run are made.

Exit Computer Control Display:

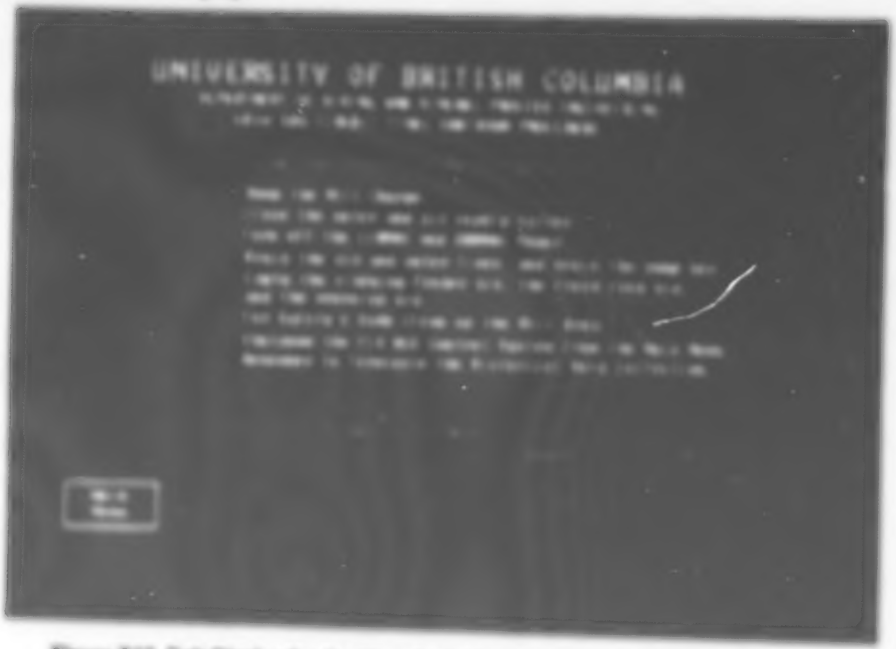


Figure 011. Exit Display for the 6600 SAG MSB Circuit at the University of British Columbia.

Table 011. Key Macros for the Exit Display Used in the 6600 SAG MSB Circuit at the University of British Columbia.

Key	Function
<F1>	HELP. Applies to all displays.
<F2>	MAIN Menu. Goes to the main menu.

Single Controller Trend Displays:

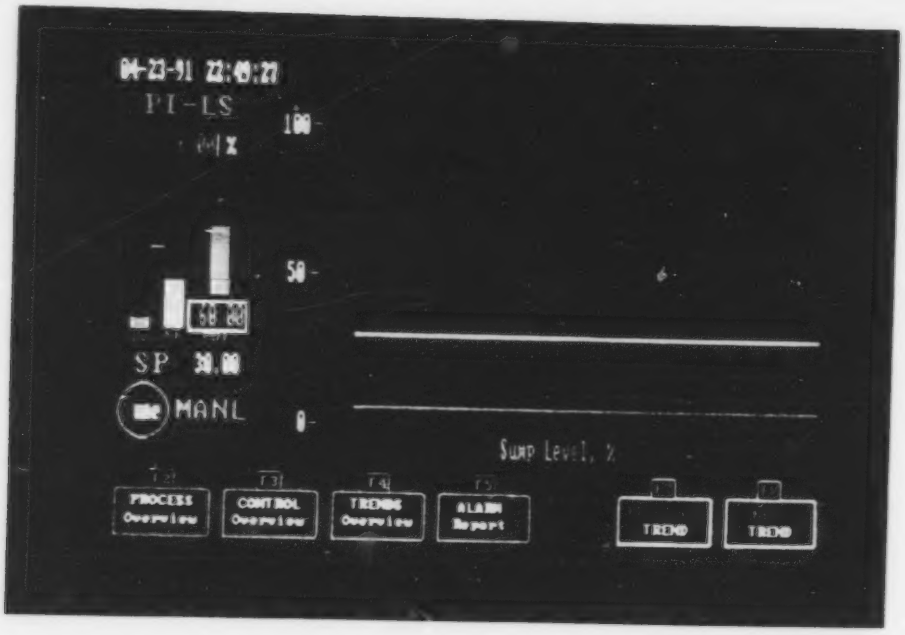


Figure B13. Level Controller Trend Display for the 60cm SAG Mill Circuit at the University of British Columbia.

Table B12. Key Macros for the Level Controller Trend Display Used in the 60cm SAG Mill Circuit at the University of British Columbia.

Key	Function
<F1>	HELP. Applies to all displays
<F2>	PROCESS Overview. Invokes the PROCESS Overview display.
<F3>	CONTROL Overview. Invokes the CONTROL Overview display.
<F4>	TRENDS Overview. Invokes the TRENDS Overview display.
<F5>	ALARM Report. Invokes the ALARM Report display.
<F7>	PREVIOUS Trend. Invokes the PREVIOUS Trend display (mill weight).
<F8>	NEXT Trend. Invokes the NEXT Trend display (sump water).
<CTRL>A	ACKNOWLEDGE ALARMS.
<ALT>M	SELECT CONTROLLER AUTO/MANUAL MODE. Repeating keystroke will select the next controller. Type A<ENTER> for AUTO, M<ENTER> for MANUAL.
<ALT>O	SELECT CONTROLLER OUTPUT. Repeating keystroke will select the next controller. Type the required numerical value followed by <ENTER>.
<ALT>S	SELECT CONTROLLER SETPOINT. Repeating keystroke will select the next controller. Type the required numerical value followed by <ENTER>.
<ALT>T	TUNE CONTROLLER. Invokes CONTROLLER Tuning display. Note: The display is password protected. Press <F9> followed by the pass word to use the display. If you do not know the password press <F6> to return to the trend display.

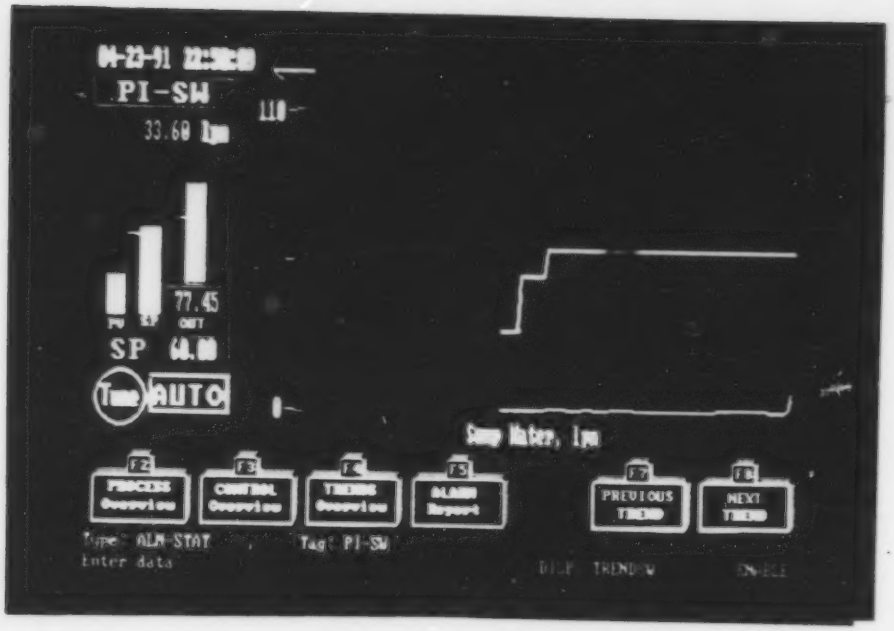


Figure B14. Sump Water Controller Trend Display for the 60cm SAG Mill Circuit at the University of British Columbia.

Table B13. Key Macros for the Sump Water Controller Trend Display Used in the 60cm SAG Mill Circuit at the University of British Columbia.

Key	Function
<F1>	HELP. Applies to all displays
<F2>	PROCESS Overview. Invokes the PROCESS Overview display.
<F3>	CONTROL Overview. Invokes the CONTROL Overview display.
<F4>	TRENDS Overview. Invokes the TRENDS Overview display.
<F5>	ALARM Report. Invokes the ALARM Report display.
<F7>	PREVIOUS Trend. Invokes the PREVIOUS Trend display (sump level).
<F8>	NEXT Trend. Invokes the NEXT Trend display (mill water).
<CTRL>A	ACKNOWLEDGE ALARMS.
<ALT>M	SELECT CONTROLLER AUTO/MANUAL MODE. Repeating keystroke will select the next controller. Type A<ENTER> for AUTO, M<ENTER> for MANUAL.
<ALT>O	SELECT CONTROLLER OUTPUT. Repeating keystroke will select the next controller. Type the required numerical value followed by <ENTER>.
<ALT>S	SELECT CONTROLLER SETPOINT. Repeating keystroke will select the next controller. Type the required numerical value followed by <ENTER>.
<ALT>T	TUNE CONTROLLER. Invokes CONTROLLER Tuning display. Note: The display is password protected. Press <F9> followed by the pass word to use the display. If you do not know the password press <F6> to return to the trend display.

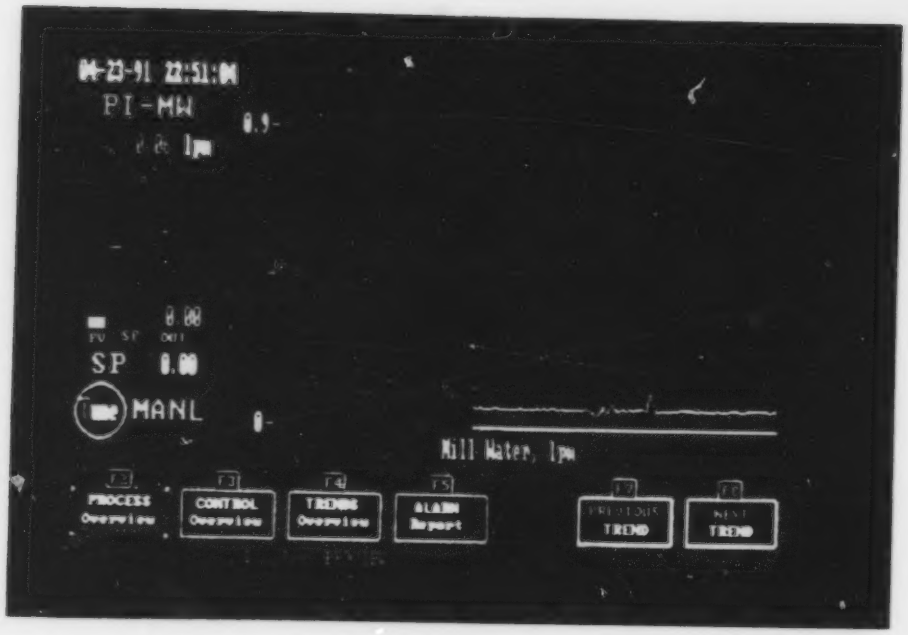


Figure B15. Mill Water Controller Display Trend for the 60cm SAG Mill Circuit at the University of British Columbia.

Table B14. Key Macros for the Mill Water Controller Display Trend Used in the 60cm SAG Mill Circuit at the University of British Columbia.

Key	Function
<F1>	HELP. Applies to all displays
<F2>	PROCESS Overview. Invokes the PROCESS Overview display.
<F3>	CONTROL Overview. Invokes the CONTROL Overview display.
<F4>	TRENDS Overview. Invokes the TRENDS Overview display.
<F5>	ALARM Report. Invokes the ALARM Report display.
<F7>	PREVIOUS Trend. Invokes the PREVIOUS Trend display (sump water).
<F8>	NEXT Trend. Invokes the NEXT Trend display (mill speed).
<CTRL>A	ACKNOWLEDGE ALARMS.
<ALT>M	SELECT CONTROLLER AUTO/MANUAL MODE. Repeating keystroke will select the next controller. Type A<ENTER> for AUTO, M<ENTER> for MANUAL.
<ALT>O	SELECT CONTROLLER OUTPUT. Repeating keystroke will select the next controller. Type the required numerical value followed by <ENTER>.
<ALT>S	SELECT CONTROLLER SETPOINT. Repeating keystroke will select the next controller. Type the required numerical value followed by <ENTER>.
<ALT>T	TUNE CONTROLLER. Invokes CONTROLLER Tuning display. Note: The display is password protected. Press <F9> followed by the pass word to use the display. If you do not know the password press <F6> to return to the trend display.

Figure B16. Mill Speed Controller Trend Display for the 60cm SAG Mill Circuit at the University of British Columbia.

Table B15. Key Macros for the Mill Speed Controller Trend Display Used in the 60cm SAG Mill Circuit at the University of British Columbia.

Key	Function
<F1>	HELP. Applies to all displays
<F2>	PROCESS Overview. Invokes the PROCESS Overview display.
<F3>	CONTROL Overview. Invokes the CONTROL Overview display.
<F4>	TRENDS Overview. Invokes the TRENDS Overview display.
<F5>	ALARM Report. Invokes the ALARM Report display.
<F7>	PREVIOUS Trend. Invokes the PREVIOUS Trend display (mill water).
<F8>	NEXT Trend. Invokes the NEXT Trend display (mill weight).
<CTRL>A	ACKNOWLEDGE ALARMS.
<ALT>M	SELECT CONTROLLER AUTO/MANUAL MODE. Repeating keystroke will select the next controller. Type A<ENTER> for AUTO, M<ENTER> for MANUAL.
<ALT>O	SELECT CONTROLLER OUTPUT. Repeating keystroke will select the next controller. Type the required numerical value followed by <ENTER>.
<ALT>S	SELECT CONTROLLER SETPOINT. Repeating keystroke will select the next controller. Type the required numerical value followed by <ENTER>.
<ALT>T	TUNE CONTROLLER. Invokes CONTROLLER Tuning display. Note: The display is password protected. Press <F9> followed by the pass word to use the display. If you do not know the password press <F6> to return to the trend display.

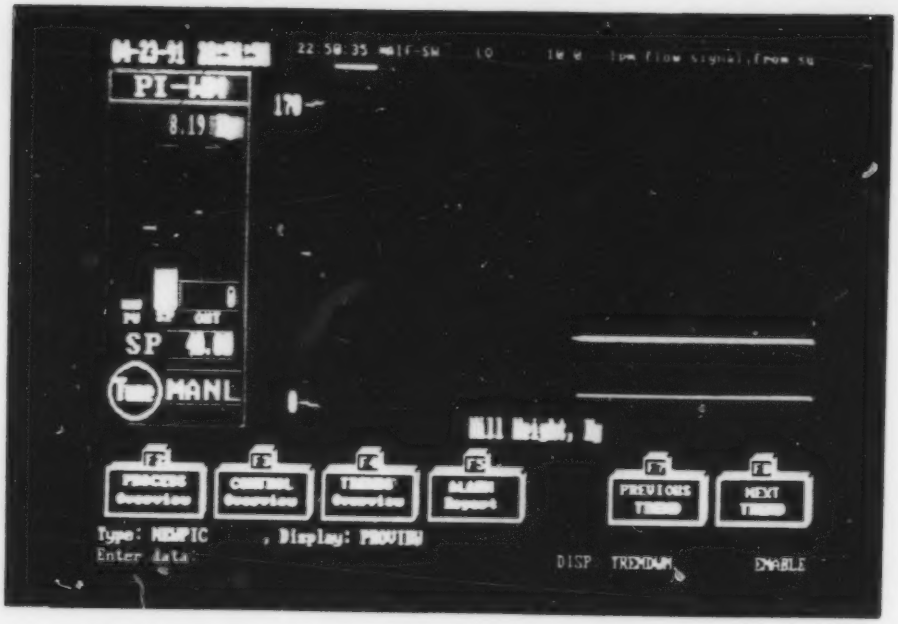


Figure B17. Mill Weight Controller Trend Display for the 60cm SAG Mill Circuit at the University of British Columbia.

Table B16. Key Macros for the Mill Weight Controller Trend Display Used in the 60cm SAG Mill Circuit at the University of British Columbia.

Key	Function
<F1>	HELP. Applies to all displays
<F2>	PROCESS Overview. Invokes the PROCESS Overview display.
<F3>	CONTROL Overview. Invokes the CONTROL Overview display.
<F4>	TRENDS Overview. Invokes the TRENDS Overview display.
<F5>	ALARM Report. Invokes the ALARM Report display.
<F7>	PREVIOUS Trend. Invokes the PREVIOUS Trend display (mill speed).
<F8>	NEXT Trend. Invokes the NEXT Trend display (sump level).
<CTRL>A	ACKNOWLEDGE ALARMS.
<ALT>M	SELECT CONTROLLER AUTO/MANUAL MODE. Repeating keystroke will select the next controller. Type A<ENTER> for AUTO, M<ENTER> for MANUAL.
<ALT>O	SELECT CONTROLLER OUTPUT. Repeating keystroke will select the next controller. Type the required numerical value followed by <ENTER>.
<ALT>S	SELECT CONTROLLER SETPOINT. Repeating keystroke will select the next controller. Type the required numerical value followed by <ENTER>.
<ALT>T	TUNE CONTROLLER. Invokes CONTROLLER Tuning display. Note: The display is password protected. Press <F9> followed by the pass word to use the display. If you do not know the password press <F6> to return to the trend display.

Single Controller Tuning Displays:

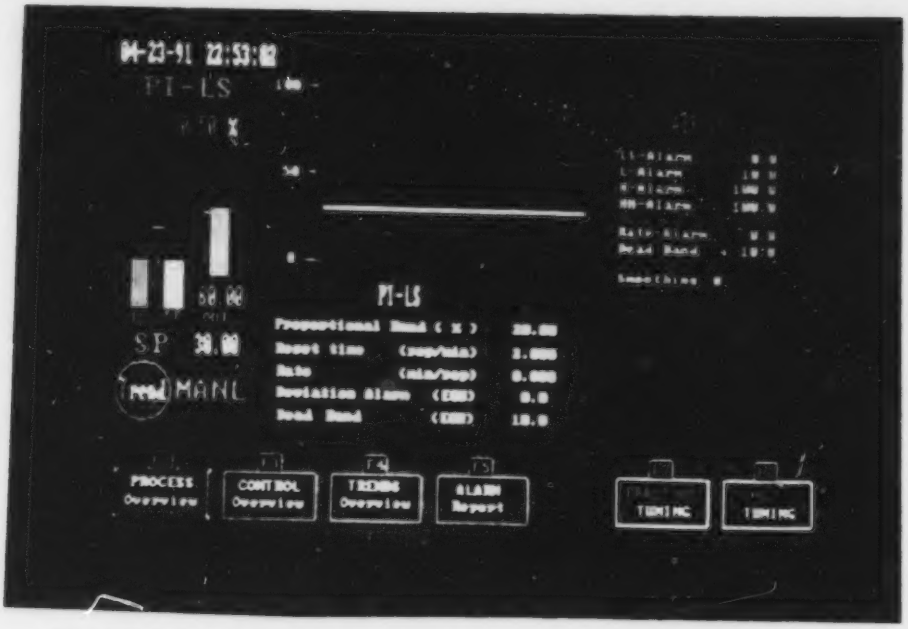


Figure B18. Sump Level Controller Tuning Display for the 60cm SAG Mill Circuit at the University of British Columbia.

Table B17. Key Macros for the Sump Level Controller Tuning Display Used in the 60cm SAG Mill Circuit at the University of British Columbia.

Key	Function
<F1>	HELP. Applies to all displays
<F2>	PROCESS Overview. Invokes the PROCESS Overview display.
<F3>	CONTROL Overview. Invokes the CONTROL Overview display.
<F4>	TRENDS Overview. Invokes the TRENDS Overview display.
<F5>	ALARM Report. Invokes the ALARM Report display.
<F6>	RETURN TO TREND. Use to return to TREND Overview display if password is unknown.
<F7>	PREVIOUS Tuning. Invokes the PREVIOUS Tuning display (mill weight).
<F8>	NEXT Tuning. Invokes the NEXT Tuning display (sump water).
<F9>	ENTER PASSWORD. Allows user to enter password to unlock display.
<CTRL>A	ACKNOWLEDGE ALARMS.
<ALT>I	SELECT ANALOG INPUT PARAMETERS. Moves cursor to the analog parameter window. Move between parameters using the up and down arrow keys. Type in numerical value followed by <ENTER>.
<ALT>P	SELECT CONTROLLER PARAMETERS. Moves cursor to the controller parameters. Move between parameters using the up and down arrow keys. Type in numerical value followed by <ENTER>.
<ALT>M	SELECT CONTROLLER AUTO/MANUAL MODE. Repeating keystroke will select the next controller. Type A<ENTER> for AUTO, M<ENTER> for MANUAL.
<ALT>O	SELECT CONTROLLER OUTPUT. Repeating keystroke will select the next controller. Type the required numerical value followed by <ENTER>.
<ALT>S	SELECT CONTROLLER SETPOINT. Repeating keystroke will select the next controller. Type the required numerical value followed by <ENTER>.
<ALT>T	TREND. Return to TREND display.

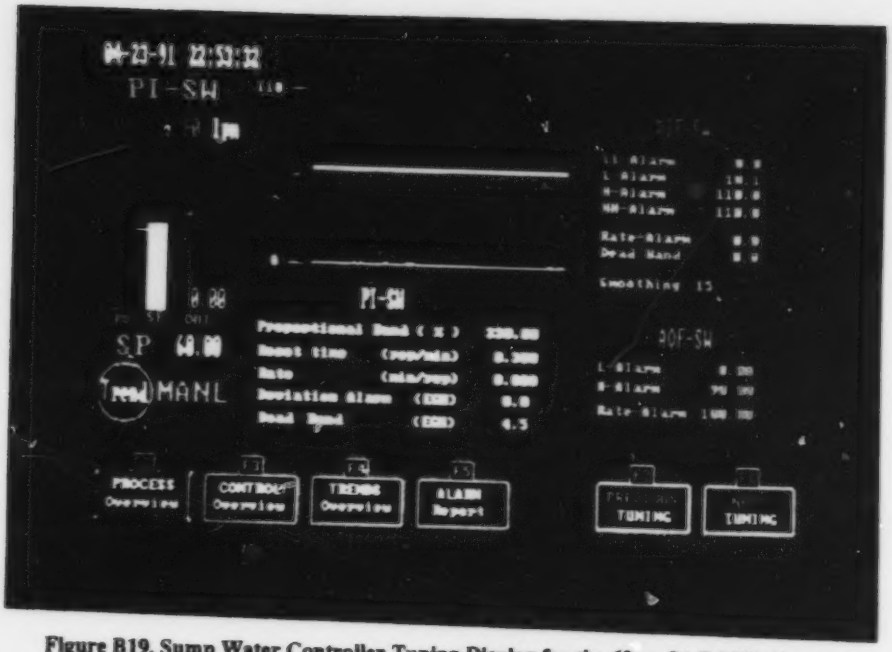


Figure B19. Sump Water Controller Tuning Display for the 60cm SAG Mill Circuit at the University of British Columbia.

Table B18. Key Macros for the Sump Water Controller Tuning Display Used in the 60cm SAG Mill Circuit at the University of British Columbia.

Key	Function
<F1>	HELP. Applies to all displays
<F2>	PROCESS Overview. Invokes the PROCESS Overview display.
<F3>	CONTROL Overview. Invokes the CONTROL Overview display.
<F4>	TRENDS Overview. Invokes the TRENDS Overview display.
<F5>	ALARM Report. Invokes the ALARM Report display.
<F6>	RETURN TO TREND. Use to return to TREND Overview display if password is unknown.
<F7>	PREVIOUS Tuning. Invokes the PREVIOUS Tuning display (sump level).
<F8>	NEXT Tuning. Invokes the NEXT Tuning display (mill water).
<F9>	ENTER PASSWORD. Allows user to enter password to unlock display.
<CTRL>A	ACKNOWLEDGE ALARMS.
<ALT>C	SELECT ANALOG OUTPUT PARAMETERS. Moves cursor to the analog output parameter window. Move between parameters using the up and down arrow keys. Type in numerical value followed by <ENTER>.
<ALT>I	SELECT ANALOG INPUT PARAMETERS. Moves cursor to the analog input parameter window. Move between parameters using the up and down arrow keys. Type in numerical value followed by <ENTER>.
<ALT>P	SELECT CONTROLLER PARAMETERS. Moves cursor to the controller parameters. Move between parameters using the up and down arrow keys. Type in numerical value followed by <ENTER>.
<ALT>M	SELECT CONTROLLER AUTO/MANUAL MODE. Repeating keystroke will select the next controller. Type A<ENTER> for AUTO, M<ENTER> for MANUAL.
<ALT>O	SELECT CONTROLLER OUTPUT. Repeating keystroke will select the next controller. Type the required numerical value followed by <ENTER>.
<ALT>S	SELECT CONTROLLER SETPOINT. Repeating keystroke will select the next controller. Type the required numerical value followed by <ENTER>.
<ALT>T	TREND. Return to TREND display.

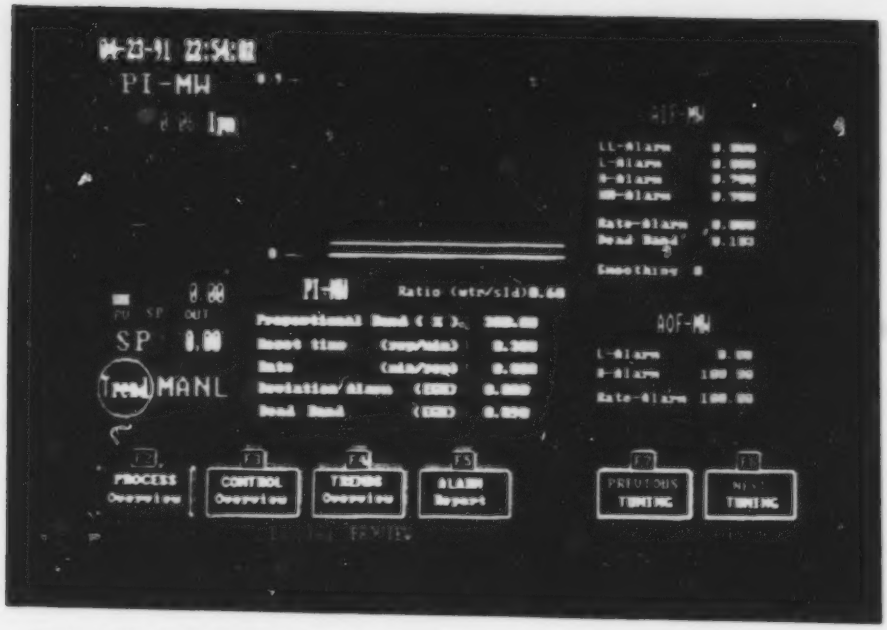


Figure B20. Mill Water Controller Tuning Display for the 60cm SAG Mill Circuit at the University of British Columbia.

Table B19. Key Macros for the Mill Water Controller Tuning Display Used in the 60cm SAG Mill Circuit at the University of British Columbia.

Key	Function
<F1>	HELP. Applies to all displays
<F2>	PROCESS Overview. Invokes the PROCESS Overview display.
<F3>	CONTROL Overview. Invokes the CONTROL Overview display.
<F4>	TRENDS Overview. Invokes the TRENDS Overview display.
<F5>	ALARM Report. Invokes the ALARM Report display.
<F6>	RETURN TO TREND. Use to return to TREND Overview display if password is unknown.
<F7>	PREVIOUS Tuning. Invokes the PREVIOUS Tuning display (sump water).
<F8>	NEXT Tuning. Invokes the NEXT Tuning display (mill speed).
<F9>	ENTER PASSWORD. Allows user to enter password to unlock display.
<CTRL>A	ACKNOWLEDGE ALARMS.
<ALT>C	SELECT ANALOG OUTPUT PARAMETERS. Moves cursor to the analog output parameter window. Move between parameters using the up and down arrow keys. Type in numerical value followed by <ENTER>.
<ALT>I	SELECT ANALOG INPUT PARAMETERS. Moves cursor to the analog input parameter window. Move between parameters using the up and down arrow keys. Type in numerical value followed by <ENTER>.
<ALT>P	SELECT CONTROLLER PARAMETERS. Moves cursor to the controller parameters. Move between parameters using the up and down arrow keys. Type in numerical value followed by <ENTER>.
<ALT>R	SELECT MILL WATER RATIO. Type in numerical value followed by <ENTER>.
<ALT>M	SELECT CONTROLLER AUTO/MANUAL MODE. Repeating keystroke will select the next controller. Type A<ENTER> for AUTO, M<ENTER> for MANUAL.
<ALT>O	SELECT CONTROLLER OUTPUT. Repeating keystroke will select the next controller. Type the required numerical value followed by <ENTER>.
<ALT>S	SELECT CONTROLLER SETPOINT. Repeating keystroke will select the next controller. Type the required numerical value followed by <ENTER>.
<ALT>T	TREND. Return to TREND display.

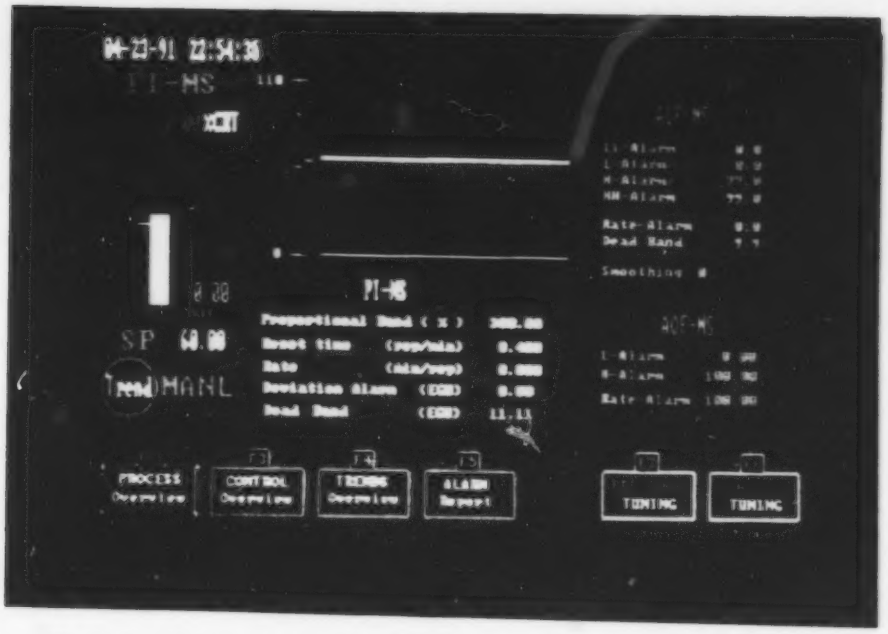


Figure B21. Mill Speed Controller Tuning Display for the 60cm SAG Mill Circuit at the University of British Columbia.

Table B20. Key Macros for the Mill Speed Controller Tuning Display Used in the 60cm SAG Mill Circuit at the University of British Columbia.

Key	Function
<F1>	HELP. Applies to all displays.
<F2>	PROCESS Overview. Invokes the PROCESS Overview display.
<F3>	CONTROL Overview. Invokes the CONTROL Overview display.
<F4>	TRENDS Overview. Invokes the TRENDS Overview display.
<F5>	ALARM Report. Invokes the ALARM Report display.
<F6>	RETURN TO TREND. Use to return to TREND Overview display if password is unknown.
<F7>	PREVIOUS Tuning. Invokes the PREVIOUS Tuning display (mill water).
<F8>	NEXT Tuning. Invokes the NEXT Tuning display (mill weight).
<F9>	ENTER PASSWORD. Allows user to enter password to unlock display.
<CTRL>A	ACKNOWLEDGE ALARMS.
<ALT>C	SELECT ANALOG OUTPUT PARAMETERS. Moves cursor to the analog output parameter window. Move between parameters using the up and down arrow keys. Type in numerical value followed by <ENTER>.
<ALT>I	SELECT ANALOG INPUT PARAMETERS. Moves cursor to the analog input parameter window. Move between parameters using the up and down arrow keys. Type in numerical value followed by <ENTER>.
<ALT>P	SELECT CONTROLLER PARAMETERS. Moves cursor to the controller parameters. Move between parameters using the up and down arrow keys. Type in numerical value followed by <ENTER>.
<ALT>M	SELECT CONTROLLER AUTO/MANUAL MODE. Repeating keystroke will select the next controller. Type A<ENTER> for AUTO, M<ENTER> for MANUAL.
<ALT>O	SELECT CONTROLLER OUTPUT. Repeating keystroke will select the next controller. Type the required numerical value followed by <ENTER>.
<ALT>S	SELECT CONTROLLER SETPOINT. Repeating keystroke will select the next controller. Type the required numerical value followed by <ENTER>.
<ALT>T	TREND. Return to TREND display.

Figure B22. Mill Weight Controller Tuning Display for the 60cm SAG Mill Circuit at the University of British Columbia.

Table B21. Key Macros for the Mill Weight Controller Tuning Display Used in the 60cm SAG Mill Circuit at the University of British Columbia.

Key	Function
<F1>	HELP. Applies to all displays
<F2>	PROCESS Overview. Invokes the PROCESS Overview display.
<F3>	CONTROL Overview. Invokes the CONTROL Overview display.
<F4>	TRENDS Overview. Invokes the TRENDS Overview display.
<F5>	ALARM Report. Invokes the ALARM Report display.
<F6>	RETURN TO TREND. Use to return to TREND Overview display if password is unknown.
<F7>	PREVIOUS Tuning. Invokes the PREVIOUS Tuning display (mill speed).
<F8>	NEXT Tuning. Invokes the NEXT Tuning display (sump level).
<F9>	ENTER PASSWORD. Allows user to enter password to unlock display.
<CTRL>A	ACKNOWLEDGE ALARMS.
<ALT>I	SELECT ANALOG INPUT PARAMETER. Moves to the analog parameter window. Move between parameters using the up and down arrow keys. Type in numerical value followed by <ENTER>.
<ALT>P	SELECT CONTROLLER PARAMETERS. Moves to the controller parameters. Move between parameters using the up and down arrow keys. Type in numerical value followed by <ENTER>.
<ALT>M	SELECT CONTROLLER AUTO/MANUAL MODE. Repeating keystroke will select the next controller. Type A<ENTER> for AUTO, M<ENTER> for MANUAL.
<ALT>O	SELECT CONTROLLER OUTPUT. Repeating keystroke will select the next controller. Type the required numerical value followed by <ENTER>.
<ALT>S	SELECT CONTROLLER SETPOINT. Repeating keystroke will select the next controller. Type the required numerical value followed by <ENTER>.
<ALT>T	TUNE CONTROLLER. Invokes CONTROLLER Tuning display. Note: The display is password protected. Press <F9> followed by the pass word to use the display. If you do not know the password press <F6> to return to the trend display.

Appendix C:
Example Report

Figure C1. Summary Report for the 60cm SAG Mill Circuit at the University of British Columbia.

UNIVERSITY OF BRITISH COLUMBIA
DEPARTMENT OF MINING AND MINERAL PROCESS ENGINEERING

60cm SAG CIRCUIT
STEADY STATE CONDITIONS

Date: 04-19-91
Sample: FINAL PRACTICE TEST
Run # : 1ST FULL

NOTE: Historical Data can be found in the file 91040500.H24
The file can be viewed graphically using the HISTORICAL DATA DISPLAY package of the FIX (see the FIX Manual).

RUN SETUP CONDITIONS

Ball Load (Kg)	29.60
Water Ratio Setpoint (Water:Total Feed of Solids)	0.600
Mill Speed Setpoint (% of Critical Speed)	60.00
Mill Load Setpoint (Kg)	46.00

STEADY STATE CONDITIONS (average over the last hour)

Time at End of Test	20:16:36
Fresh Feed Flowrate (Grams/Minute)	181
Screen Oversize Flowrate (Grams/Minute)	50
Total Feed to Mill (Grams/Minute)	231
Mill Speed (% of Critical Speed)	59.8
Mill Power * (W)	237.7
Mill Load (Kg)	46.13
Sump Water Flowrate (Liters/Minute)	94.6
Screen Feed Flowrate (Liters/Minute)	94.8
Mill Water Flowrate (Liters/Minute)	0.477
Amount of Ore Used (Kg)	47.80

* NOTE: Power Draw has been corrected for No Load Power

Figure C2. Summary Report for the 60cm SAG Mill Circuit at the University of British Columbia (cont).

CHECK OF STEADY STATE CONDITIONS

A) One Minute Averages Over The Last Twenty Minutes

Time	Frsh Feed	O/S	Tot Feed	Mill Sp	Mill Power
19:56:05	180	55	235	59	237.87
19:57:05	183	60	243	59	247.87
19:58:05	178	50	228	59	233.80
19:59:05	184	49	233	59	244.97
20:00:05	181	45	226	60	235.55
20:01:05	181	47	228	60	225.55
20:02:05	173	49	222	60	245.25
20:03:05	180	55	235	59	237.87
20:04:05	183	60	243	59	247.87
20:05:05	178	50	228	59	233.80
20:06:05	184	49	233	59	244.97
20:07:05	181	45	226	60	235.55
20:08:05	181	47	228	60	225.55
20:09:05	173	49	222	60	245.25
20:10:05	180	55	235	59	237.87
20:11:05	183	60	243	59	247.87
20:12:05	178	50	228	59	233.80
20:13:05	184	49	233	59	244.97
20:14:05	181	45	226	60	235.55
20:15:05	181	47	228	60	225.55
20:16:05	173	49	222	60	245.25

Time	Mill Load	Sump Watr	Scrn Feed	Mill Water
19:56:06	46.70	95.2	95.3	0.477
19:57:06	45.00	94.2	95.0	0.478
19:58:06	46.75	93.1	94.5	0.477
19:59:06	46.40	95.0	95.1	0.477
20:00:06	45.77	94.9	95.1	0.477
20:01:06	46.70	95.2	95.3	0.478
20:02:06	45.72	94.9	95.0	0.477
20:03:06	46.70	95.2	95.3	0.477
20:04:06	45.00	94.2	95.0	0.478
20:05:06	46.75	93.1	94.5	0.477
20:06:06	46.40	95.0	95.1	0.477
20:07:06	45.77	94.9	95.1	0.477
20:08:06	46.70	95.2	95.3	0.478
20:09:06	45.72	94.9	95.0	0.477
20:10:06	46.70	95.2	95.3	0.477
20:11:06	45.00	94.2	95.0	0.478
20:12:06	46.75	93.1	94.5	0.477
20:13:06	46.40	95.0	95.1	0.477
20:14:06	45.77	94.9	95.1	0.477
20:15:06	46.70	95.2	95.3	0.478
20:16:06	45.72	94.9	95.0	0.477

Figure C3. Summary Report for the 60cm SAG Mill Circuit at the University of British Columbia (cont).

B) Ten Minute Averages Over The Last Hour

Time	Frsh Feed	O/S	Tot Feed	Mill Sp	Mill Power
19:16:37	179.9	50.0	231.0	59.9	238.33
19:26:37	181.2	49.8	229.8	59.8	238.12
19:36:37	180.4	50.0	231.2	59.9	236.88
19:46:37	182.9	50.3	230.9	59.9	235.22
19:56:37	181.3	50.1	233.3	60.0	238.77
20:06:37	180.5	51.4	231.9	59.3	239.75
20:16:37	179.5	49.6	229.1	59.6	237.72

Time	Mill Load	Sump watr	Scrn Feed	Mill Water
19:16:37	46.13	94.2	95.0	0.477
19:26:37	46.14	94.6	94.1	0.477
19:36:37	46.13	94.3	94.9	0.477
19:46:37	46.14	94.5	94.8	0.477
19:56:37	46.13	94.7	95.1	0.477
20:06:37	46.12	94.5	95.0	0.477
20:16:37	46.12	94.8	95.1	0.477

Appendix D:
Calibration of Sensors

Introduction:
Calibration of the sensors and computer programs is necessary to ensure correct and repeatable operation of the SAG mill circuit. This section assumes the reader has read the operating manual and is familiar with the technical information in the manuals stored under the computer monitor at the SAG mill. The following procedures are given for calibrating the fresh feed and oversize measurement and control systems. Sump level and sump water flow rate procedures are included. The screen feed calibration procedure is given. Procedures for calibration of the mill speed, mill torque, mill weight, and mill water flow are also given.

Calibration of Fresh Feed Rate Apparatus:
The fresh feed apparatus is very important to the operation of the circuit. Figure 3 is a drawing of the fresh feed apparatus. A detailed description of the apparatus and its operation is given on page 4 of this manual. The fresh feed program listing is in appendix A. Using the following procedure(s) will help ensure the correct operation of the fresh feed system.

Fresh Feed Bin Load Cell Calibration:
Apparatus:
Scale, one Kg capacity
Two small bags of sand:
one about 500g,
and one about 300g
Jewellers screw driver
Key to turn on the computer, found in room 310A

Procedure:
1. Turn on/off the following equipment:
Turn off the manual on/off switch at the mill motor actuator
(Ratiotrol™ control box)
Turn off the manual on/off switch at the vibrating feeder and
make sure the fresh feed bin is empty
Switch on 110VAC power circuit breaker
Turn on the computer

2. The computer control program starts automatically when the computer is turned on. The startup parameter screen will be displayed first (displays are shown in appendix B). Hit the <F9> key to go to the SENSOR Calibration display (CALIB). The display shows the values of all of the signals brought into or sent from the computer by the 60cm circuit. They are shown with their tag names (listed in appendix H).

3. Weigh the two bags of sand. Make sure the feed bin can move up and down freely. Look at the value of AI-FB tag on the CALIB screen. The empty bin should weigh 0.0g. If it does not show 0.0g use the Jewellers screwdriver to adjust the zero on the ACTION PAK™ module in the signal panel box (far left panel box) labeled "fresh feed" until it does. Next, put the heavy sand bag in the bin and adjust the span until the tag value is correct. Remove the heavy bag and adjust the zero. Repeat the adjustments until the measurements are correct. Check the calibration with the ~300g sand bag. The weights should be within one percent.

4. Continue with the circuit calibration by following the instructions in the next sections or return to the startup parameter display by hitting <F8>. If you wish to make a run fill in the requested information or leave the system by hitting <F10>. You will go to the main menu. Hitting the <F10> key again will prompt the user for the shut down code. Then hit <alt><Y> to exit to DOS. Turn on/off the following equipment:
Turn on the manual on/off switch at the mill motor actuator
(Ratiotrol™ control box)
Turn on the manual on/off switch at the vibrating feeder
Switch off 110VAC power circuit breaker
Turn off the computer
Clean up

Procedure for Checking the Fresh Feed Rate:
Note: The fresh feed load cell (see above) must be calibrated before the fresh feed rate can be checked.

Apparatus:
Scale, twenty Kg capacity
One bin, for the crushed ore
One bucket, medium
Stop watch, accurate to one second
Key to turn on the computer, found in room 310A

Material:
-30mm crushed ore, 15Kg

Procedure:
1. Turn on/off the following equipment:
Turn off the manual on/off switch at the mill motor actuator
(Ratiotrol™ control box)
Turn on the manual on/off switch at the vibrating feeder, add 15Kg
of crushed ore (-30mm) to the vibrating feeder hopper
Switch on 110VAC power circuit breaker
Switch on 208VAC power circuit breaker
Open the compressed air supply valve
Turn on the computer

2. Remove the mill door (see page 25 of the Operator's Manual) and place a tared bucket under the feed spout. You must hold the bucket or the feed will tip the bucket over when the feed falls into it. Ensure the feed bin can move freely up and down.

3. The computer control program starts automatically when the computer is turned on. The startup parameter screen will be displayed first (displays are shown in appendix B). Hit the <F9> key to go to the SENSOR Calibration display (CALIB). The display shows the values of all of the signals brought into or sent from the computer by the 60cm circuit. They are shown with their tag names (listed in appendix H).

4. Use the cursor control keys to highlight the requested fresh feed rate value on the CALIB screen. The controller starts in manual mode. Type in the desired flow rate, start with <200> <ENTER>. Begin the time when the feeder starts. Collect the feed for five to ten minutes. Repeat for higher flow rates if desired, the maximum flow rate is 2400gpm. The flow rate should be within one percent. If the feed rate is wrong, and the fresh feed bin load cell is calibrated properly (see the previous procedure), the C program, FFEED.C, must be modified. See appendix A for the listing.

5. Continue with the circuit calibration by following the instructions in the next sections or return to the startup parameter display by hitting <F8>. If you wish to make a run fill in the requested information or leave the system by hitting <F10>. You will go to the main menu. Hitting the <F10> key again will prompt the user for the shut down code. Then hit <alt><Y> to exit to DOS. Turn on/off the following equipment:
Turn on the manual on/off switch at the mill motor actuator
(Ratiotrol™ control box)
Switch off 110VAC power circuit breaker
Switch off 208VAC power circuit breaker
Turn off the computer
Close the compressed air supply valve
Clean up

Calibration of Oversize Flow Rate Apparatus:
The oversize apparatus measures the amount of screen oversize returned to the mill. Figure 4 is a drawing of the oversize apparatus. A detailed description of the apparatus and its operation is given on page 4 of this manual. The Oversize program listing is in appendix A. Using the following procedure(s) will help ensure the correct operation of the fresh feed system.

Oversize Bin Load Cell Calibration:
Apparatus:
Scale, one Kg capacity
Two small bags of sand
about 300g
about 100g
Jewellers screw driver
Key to turn on the computer, found in room 310A

Procedure:
1. Turn on/off the following equipment:
Turn off the manual on/off switch at the mill motor actuator
(Ratiotrol™ control box)
Switch on 110VAC power circuit breaker
Turn on the computer

2. The computer control program starts automatically when the computer is turned on. The startup parameter screen will be displayed first (displays are shown in appendix B). Hit the <F9> key to go to the SENSOR Calibration display (CALIB). The display shows the values of all of the signals brought into or sent from the computer by the 60cm circuit. They are shown with their tag names (listed in appendix H).

3. Weigh the two bags of sand. Make sure the oversize bin can move freely. Look at the value of AI-OB tag on the CALIB display. The empty bin should weigh 0.0g. If it does not show 0.0g use the Jewellers screwdriver to adjust the zero on the ACTION PAK™ module in the signal panel box labeled "oversize" until it does. Next, put the heavy sand bag in the bin and adjust the span until the tag value is correct. Remove the heavy bag and repeat the adjustments until the measurements are correct. Check the calibration with the ~100g sand bag. The weights should be within one percent.

4. Continue with the circuit calibration by following the instructions in the next sections or return to the startup parameter display by hitting <F8>. If you wish to make a run fill in the requested information or leave the system by hitting <F10>. You will go to the main menu. Hitting the <F10> key again will prompt the user for the shut down code. Then hit <alt><Y> to exit to DOS. Turn on/off the following equipment:
Turn on the manual on/off switch at the mill motor actuator
(Ratiotrol™ control box)
Turn on the manual on/off switch at the vibrating feeder
Switch off 110VAC power circuit breaker
Turn off the computer
Clean up

Procedure for Checking the Oversize Flow Rate:
Note: The oversize load cell (see above) must be calibrated before the oversize flow rate can be checked.

Apparatus:
Scale, four Kg capacity
one tray, medium
one bucket, medium
Stop watch, accurate to one second
Key to turn on the computer, found in room 310A

Material:
-10mm crushed ore, 2Kg sample

Procedure:
1. Turn on/off the following equipment:
Turn off the manual on/off switch at the mill motor actuator
(Ratiotrol™ control box)
Switch on 110VAC power circuit breaker
Open the compressed air supply valve
Turn on the computer

2. Remove the mill door (see page 25 of the Operator's Manual) and place a tared bucket under the feed spout. You must hold the bucket or the oversize will tip the bucket over when the it falls into the bucket. Ensure the oversize bin can move freely up and down.

3. The computer control program starts automatically when the computer is turned on. The startup parameter screen will be displayed first (displays are shown in appendix B). Hit the <F9> key to go to the SENSOR Calibration display (CALIB). The display shows the values of all of the signals brought into or sent from the computer by the 60cm circuit. They are shown with their tag names (listed in appendix H).

4. Look at the oversize rate value on the CALIB screen, it is zero. The system is ready to measure the oversize flow rate. Make sure the bucket will catch the crushed ore as it falls from the oversize bin and through the feed spout. Start the stop watch and SLOWLY add crushed ore to the oversize bin. When the bin weight reaches about 100g the oversize gate closes, stop adding ore. When the gate opens again start adding crushed ore. Collect the crushed ore for about five minutes. Weigh the bucket. The flow rate should be within one percent of the actual flow rate. If the flow rate is wrong, and the oversize bin load cell is calibrated properly (see the previous procedure), the C program, OS.C, must be modified. See appendix A for a listing.

5. Continue with the circuit calibration by following the instructions in the next sections or return to the startup parameter display by hitting <F8>. If you wish to make a run fill in the requested information or leave the system by hitting <F10>. You will go to the main menu. Hitting the <F10> key again will prompt the user for the shut down code. Then hit <alt><Y> to exit to DOS. Turn on/off the following equipment:
Turn on the manual on/off switch at the mill motor actuator
(Ratiotrol™ control box)
Switch off 110VAC power circuit breaker
Turn off the computer
Close the compressed air supply valve
Clean up

Calibration of Sump Control Systems:
The procedure to adjust the sump control valve is given below. The Sump level control system has two sensors, the level sensor, and the sump water flow sensor. A description of the sensors and the control of the sump level is given on page 9 of the Operator's Manual. Technical information on the sensors is found in the manuals stored under the computer monitor at the SAG mill. The screen feed flow rate calibration procedure is also given below. Using the following procedures will help ensure the correct operation of the sump level control system.

Adjustment of Sump Water Flow Control Valve:
Apparatus:
Key to turn on the computer, found in room 310A

Procedure:
1. Turn on/off the following equipment;
Turn off the manual on/off switch at the mill motor actuator
(Ratiotrol™ control box)
Turn on the compressed air supply valve
Turn on the water supply valve
Switch on 110VAC power circuit breaker
Turn on the computer

2. The valve must not allow any water to flow when the air pressure signal is 3psig or less. The default on start up is zero flow of sump water, this will give a 3psig signal to the valve. If there is any flow refer to the control valve manual to adjust the control valve spring tension.

3. Continue with the circuit calibration by following the instructions in the next sections or if you wish to make a run fill in the requested information and hit <F2> or leave the system by hitting <F10>. You will go to the main menu. Hitting the <F10> key again will prompt the user for the shut down code. Then hit <alt><Y> to exit to DOS. Turn on/off the following equipment:
Turn on the manual on/off switch at the mill motor actuator
(Ratiotrol™ control box)
Turn off the compressed air supply valve
Turn off the water supply valve
Ensure the sump is empty and the drain plug, in the pipe tee between the centrifugal pump inlet and the sump discharge, is in place and snug
Switch off 110VAC power circuit breaker
Turn off the computer
Clean up

Sump Water Flow Calibration:

Apparatus:

Scale, 100Kg capacity
One plastic barrel, 80 liter capacity
38mm hose, 8 meter length
two hose clamps
Stopwatch
Jewellers screwdriver
Key to turn on the computer, found in room 310A

Procedure:

1. Turn on/off the following equipment.:

Turn off the manual on/off switch at the mill motor actuator (Ratiotrol™ control box)
Turn on the compressed air supply valve
Turn on the water supply valve
Switch on 208VAC power circuit breaker
Switch on 110VAC power circuit breaker
Turn on the computer

2. Use the hose clamps to attach the hose to the sump water pipe. Put the other end of the hose in the floor drain. Tare the plastic barrel and place it near the drain. Unscrew the cover of the sump water flow sensor (Foxboro™ differential pressure cell, located above and to the right when you are facing the counter).

3. The computer control program starts automatically when the computer is turned on. The startup parameter screen will be displayed first (displays are shown in appendix B). Hit the <F9> key to go to the SENSOR Calibration display (CALIB). The display shows the values of all of the signals brought into or sent from the computer by the 60cm circuit. They are shown with their tag names (listed in appendix H).

4. Use the cursor control keys to highlight the AO-SW tag value on the CALIB screen. The controller starts in manual mode and with zero output. Look at the AI-SW tag value on the (CALIB) display. Adjust the zero of the flow sensor until AI-SW reads the correct value, ie. 0.0. Type in 90 <ENTER> for the AO-SW tag value. The water will start to flow. Start the stopwatch and put the hose in the barrel simultaneously. Fill the barrel about half full and weigh it. Calculate the water flow rate.

Next, adjust the span until AI-SW shows the correct value. Repeat the adjustments until the measurements are correct. Check the calibration by setting the controller output to about 50 and comparing the measured flow and the indicated flow. The flow should be within one percent.

5. Continue with the circuit calibration by following the instructions in the next sections or if you wish to make a run fill in the requested information and hit <F2> To leave the system hit <F10>. You will go to the main menu. Hitting the <F10> key again will prompt the user for the shut down code. Then hit <alt><Y> to exit to DOS. Turn on/off the following equipment:

Turn on the manual on/off switch at the mill motor actuator (Ratiotrol™ control box)
Turn off the compressed air supply valve
Turn off the water supply valve
Ensure the sump is empty and the drain plug, in the pipe tee between the centrifugal pump inlet and the sump discharge, is in place and snug
Switch off 110VAC power circuit breaker
Switch off 208VAC power circuit breaker
Turn off the computer
Clean up

Sump Level Sensor Calibration:

Apparatus:

Ruler, one meter long

Key to turn on the computer, found in room 310A

Procedure:

1. Turn on/off the following equipment:

Turn off the manual on/off switch at the mill motor actuator (Ratiotrol™ control box)

Turn on the compressed air supply valve

Turn on the water supply valve

Ensure the drain plug, in the pipe tee between the centrifugal pump inlet and the sump discharge, is in place and snug

Switch on 110VAC power circuit breaker

Switch on 208VAC power circuit breaker

Turn on the computer

2. Unscrew the cover of the level sensor. A small screw driver is held to the electronics package under the cover by a clip. The screwdriver is used to adjust the zero and span of the sensor.

3. The computer control program starts automatically when the computer is turned on. The startup parameter screen will be displayed first (displays are shown in appendix B). Hit the <F9> key to go to the SENSOR Calibration display (CALIB). The display shows the values of all of the signals brought into or sent from the computer by the 60cm circuit. They are shown with their tag names (listed in appendix H).

4. The sump is empty. Look at the value of the AI-LS tag. It shows the depth of water as a percentage of the depth of the tank (Tank depth = 65cm), ie:

when level is less than or equal to 5cm,

$$\text{AI-LS tag value} = 7.0 \qquad \text{(eq D1)}$$

when level is greater than 5cm,

$$\text{AI-LS tag value} = \frac{100 \cdot \text{water depth}}{\text{tank depth}} \qquad \text{(eq D2)}$$

If it does not show 7cm use the screwdriver to adjust the zero on the level sensor to this value. Next, fill the sump to about 80% by adding water from the hose and spigot near the computer. Measure the sump level with the ruler and adjust the span of the sensor until the AI-LS reads the correct value. Drain the tank and repeat the adjustments until the measurements are correct. Check the calibration by filling the sump to about 50% and comparing the measured level and the indicated level. The level should be within two percent.

5. Continue with the circuit calibration by following the instructions in the next sections or return to the startup parameter display by hitting <F8>. If you wish to make a run fill in the requested information or leave the system by hitting <F10>. You will go to the main menu. Hitting the <F10> key again will prompt the user for the shut down code. Then hit <alt><Y> to exit to DOS. Turn on/off the following equipment:

Turn on the manual on/off switch at the mill motor actuator
(Ratiotrol™ control box)
Turn off the compressed air supply valve
Turn off the water supply valve
Ensure the sump is empty and the drain plug, in the pipe tee between the centrifugal pump inlet and the sump discharge, is in place and snug
Switch off 110VAC power circuit breaker
Switch off 208VAC power circuit breaker
Turn off the computer
Clean up

Screen Feed Flow Sensor Calibration:

The screen feed is measured by a Foxboro™ magnetic flow meter. Technical information on the sensor is found in Technical Data for Equipment Used in the 60cm Semiautogenous Grinding (SAG) Mill at the University of British Columbia (UBC) stored under the computer monitor. It is assumed the sump water flow has been calibrated (see above).

Apparatus:

slot screwdriver

Key to turn on the computer, found in room 310A

Procedure:

1. Turn on/off the following equipment:

Turn off the manual on/off switch at the mill motor actuator (Ratiotrol™ control box)

Turn on the manual on/off switch at the vibrating screen

Turn on the manual on/off switch near the pump motor

Turn on the compressed air supply valve

Ensure the drain plug, in the pipe tee between the centrifugal pump inlet and the sump discharge, is in place and snug

Turn on the water supply valve

Switch on 110VAC power circuit breaker

Switch on 208VAC power circuit breaker

Turn on the computer

2. The computer control program starts automatically when the computer is turned on. The startup parameter screen will be displayed first (displays are shown in appendix B). Hit the <F9> key to go to the SENSOR Calibration display (CALIB). The display shows the values of all of the signals brought into or sent from the computer by the 60cm circuit. They are shown with their tag names (listed in appendix H).

3. Use the cursor control keys to highlight the DO-SM tag. Type <ON> <ENTER> to turn the vibrating screen motor on. Find AO-SW, requested sump water (as a percentage of maximum flow); AI-SW, actual sump water low rate (liters/minute); AI-SF, screen feed flow rate (liters/minute); AI-LS, sump level (as a percentage of its maximum depth); and DO-PM, pump motor on/off. These are the four links needed to calibrate the screen feed.

Use the cursor control keys to highlight the AO-SW, type <80> <ENTER>. When the level (AI-LS) reaches 45%, start the pump motor. Move the cursor to DO-PM, type <ON> <ENTER>.

4. Adjust the value of AO-SW to stabilize the sump level (AI-LS). Open the cover of the Foxboro™ magnetic flow meter and adjust the span until the AI-SF reads the same as the AI-SW.

Note: The screen feed signal is noisy, sensitive and heavily filtered. Adjust it slowly and use a mentally 'averaged' value.

5. Lower the pump speed by turning the variable sheave crank, at the pump motor, counter clockwise. Adjust the value of AO-SW to stabilize the sump level (AI-LS). Repeat step 4 but adjust the zero, not the span. Repeat the adjustments until the two signals agree. They should be within two percent.

6. Continue with the circuit calibration by following the instructions in the next sections or return to the startup parameter display by hitting <F8>. If you wish to make a run fill in the requested information or leave the system by hitting <F10>. You will go to the main menu. Hitting the <F10> key again will prompt the user for the shut down code. Then hit <alt><Y> to exit to DOS. Turn on/off the following equipment:

Turn on the manual on/off switch at the mill motor actuator
(Ratiotrol™ control box)
Turn on the manual on/off switch at the vibrating feeder
Turn on the manual on/off switch at the vibrating screen
Turn on the manual on/off switch near the pump motor
Turn off the compressed air supply valve
Ensure the sump is empty and the drain plug, in the pipe tee between the centrifugal pump inlet and the sump discharge, is in place and snug
Turn off the water supply valve
Switch off 110VAC power circuit breaker
Switch off 208VAC power circuit breaker
Clean up

Calibration of Mill Water Flow System:
The procedure to adjust the mill water control valve and the sump water flow sensor is given below. A detailed description of the sensor and the control valve is given in TECHNICAL Data for Equipment Used in the 60cm Semiautogenous Grinding (SAG) Mill at the University of British Columbia (UBC) stored under the computer monitor.

Adjustment of Mill Water Flow Control Valve:
Apparatus:
Key to turn on the computer, found in room 310A

Procedure:
1. Turn on/off the following equipment;
Turn off the manual on/off switch at the mill motor actuator (Ratiotrol™ control box)
Turn on the compressed air supply valve
Turn on the water supply valve
Switch on 110VAC power circuit breaker
Turn on the computer

2. The valve must not allow any water to flow when the air pressure signal is 3psig or less. The default on start up is zero flow of sump water, this will give a 3psig signal to the valve. Check for flow at the screen oversize funnel. If there is any flow refer to the control valve manual to adjust the control valve spring tension.

3. Continue with the circuit calibration by following the instructions in the next sections or if you wish to make a run fill in the requested information and hit <F2> or leave the system by hitting <F10>. You will go to the main menu. Hitting the <F10> key again will prompt the user for the shut down code. Then hit <alt><Y> to exit to DOS. Turn on/off the following equipment:
Turn on the manual on/off switch at the mill motor actuator (Ratiotrol™ control box)
Turn off the compressed air supply valve
Turn off the water supply valve
Ensure the sump is empty and the drain plug, in the pipe tee between the centrifugal pump inlet and the sump discharge, is in place and snug
Switch off 110VAC power circuit breaker
Turn off the computer
Clean up

Mill Water Flow Calibration:

Apparatus:
One graduated cylinder, one or two liter capacity
Stopwatch
Jewellers screwdriver
Key to turn on the computer, found in room 310A

Procedure:
1. Turn on/off the following equipment.:
Turn off the manual on/off switch at the mill motor actuator (Ratiotrol™ control box)
Turn on the compressed air supply valve
Turn on the water supply valve
Switch on 110VAC power circuit breaker
Switch on 208VAC power circuit breaker
Turn on the computer

2. Tare the bucket and place it near the oversize funnel. The mill water flows through the flexible hose in the funnel. Unscrew the cover of the mill water flow sensor (Foxboro™ differential pressure cell, located above and to the right when you are facing the counter). Lift hose out of the oversize funnel.

3. The computer control program starts automatically when the computer is turned on. The startup parameter screen will be displayed first (displays are shown in appendix B). Hit the <F9> key to go to the SENSOR Calibration display (CALIB). The display shows the values of all of the signals brought into or sent from the computer by the 60cm circuit. They are shown with their tag names (listed in appendix H).

4. Use the cursor control keys to highlight the AO-MW tag value on the CALIB screen. The controller starts in manual mode and with zero output. Look at the AI-MW tag value on the (CALIB) display. Adjust the zero of the flow sensor until AI-MW reads the correct value, ie. 0.0. Type in <90> <ENTER> for the AO-MW tag value. The water will start to flow. Start the stopwatch and put the hose in the cylinder simultaneously. Fill the cylinder for about one minute and measure it. Calculate the water flow rate.

Next, adjust the span until AI-MW shows the correct value. Repeat the adjustments until the measurements are correct. Check the calibration by setting the controller output to about 50 and comparing the measured flow and the indicated flow. The flow should be within one percent.

5. Continue with the circuit calibration by following the instructions in the next sections or if you wish to make a run fill in the requested information and hit <F2> To leave the system hit <F10>. You will go to the main menu. Hitting the <F10> key again will prompt the user for the shut down code. Then hit <alt><Y> to exit to DOS. Turn on/off the following equipment:
Turn on the manual on/off switch at the mill motor actuator (Ratiotrol™ control box)
Turn off the compressed air supply valve
Turn off the water supply valve
Ensure the sump is empty and the drain plug, in the pipe tee between the centrifugal pump inlet and the sump discharge, is in place and snug
Switch off 110VAC power circuit breaker
Switch off 208VAC power circuit breaker
Turn off the computer
Clean up

Calibration of Mill Sensors

The mill sensors are mill speed, mill torque, and mill weight. A detailed description of the mill sensors is given in the manuals stored under the computer monitor at the SAG mill. Using the following procedures will help ensure the correct operation of the mill sensors.

Checking Mill Speed:

Apparatus:

Stopwatch

Key to turn on the computer, found in room 310A

Procedure:

1. Turn on/off the following equipment:
   - Switch on 110VAC power circuit breaker
   - Switch on 208VAC power circuit breaker
   - Turn on the manual on/off switch at the mill motor actuator (Ratiotrol™ control box)
   - Turn on the computer

2. The computer control program starts automatically when the computer is turned on. The startup parameter screen will be displayed first (displays are shown in appendix B). Hit the <F9> key to go to the SENSOR Calibration display (CALIB). The display shows the values of all of the signals brought into or sent from the computer by the 60cm circuit. They are shown with their tag names (listed in appendix H).

3. Use the cursor control keys to highlight the DO-MMR tag and type <1> <ENTER>. Move the cursor to the AO-MS tag and type <50><ENTER>. The value of the AO-MSA tag on the CALIB indicates the speed of the mill as a percentage of it's critical speed (critical speed = 54rpm). Use the stopwatch and measure the speed at the torque meter shaft, in revolutions per minute. Calculate the actual percentage of critical speed (eq D3) and compare it to the indicated speed. Tag AI-MS shows the speed in revolutions per minute. Repeat using 70 and 90% AO-MS settings. The speed should be within one percent. To change the indicated speed you must modify the limits on the AIF-MS tag in the data base, see the FIX™ manual stored beneath the computer screen by the SAG mill.

$$\%\text{critical speed} = \frac{100 \cdot \text{actual speed (in rpm)}}{54} \qquad \text{eq D3}$$

4. Turn the mill speed to zero and use the DO-MMS tag to stop the mill. Continue with the circuit calibration by following the instructions in the next sections or if you wish to make a run fill in the requested information and hit <F2> To leave the system hit <F10>. You will go to the main menu. Hitting the <F10> key again will prompt the user for the shut down code. Then hit <alt><Y> to exit to DOS. Turn on/off the following equipment:
   - Switch off 110VAC power circuit breaker
   - Switch off 208VAC power circuit breaker
   - Turn off the computer
   - Clean up

Mill Torque Meter Calibration:

Apparatus:

Scale, fifty Kg capacity
One bucket
Rope, one meter
Moment arm, stored under the mill motor gear reducer
Jewellers screwdriver
Key to turn on the computer, found in room 310A

Material:

The normal steel ball charge for the 60cm circuit

Procedure:

1. Turn on/off the following equipment:
   Turn off the manual on/off switch at the mill motor actuator
   (Ratiotrol™ control box)
   Switch on 110VAC power circuit breaker
   Turn on the computer

2. Attach the special moment arm to the torque meter shaft. Weigh a bucket of steel balls and the rope, about 20Kg. Find the torque produced by this mass by multiplying the mass of the bucket, balls and rope by 0.97m. Add 1 (the torque produced by the moment arm) to this to find the total torque. Attach the rope to the bucket handle and place it near the mill motor.

3. The computer control program starts automatically when the computer is turned on. The startup parameter screen will be displayed first (displays are shown in appendix B). Hit the <F9> key to go to the SENSOR Calibration display (CALIB). The display shows the values of all of the signals brought into or sent from the computer by the 60cm circuit. They are shown with their tag names (listed in appendix H).

4. Look at the value of AI-OM tag on the CALIB screen. The indicated torque value should be zero (Kg m). Use the Jewellers screwdriver to adjust the zero setting on the ACTION PAK™ module in the signal panel box labeled "mill torque" until it does. Next, put the bucket on the farthest notch on the moment arm and adjust the span until the tag value shows the total torque (calculated in step 2 above). Remove the bucket and repeat the adjustments until the measurements are correct. Check the calibration with about 10Kg of steel in the bucket. The torque should be within one percent.

5. Continue with the circuit calibration by following the instructions in the other section or if you wish to make a run fill in the requested information and hit <F2> To leave the system hit <F10>. You will go to the main menu. Hitting the <F10> key again will prompt the user for the shut down code. Then hit <alt><Y> to exit to DOS. Turn on/off the following equipment:
   Turn on the manual on/off switch at the mill motor actuator
   (Ratiotrol™ control box)
   Switch off 110VAC power circuit breaker
   Turn off the computer
   Clean up

Mill Weight Sensor Calibration:

Apparatus:

Scale, one hundred Kg capacity
Twenty kilogram steel plate, stored in the crushing room
Five ton crane
Nylon lifting sling
Jewellers screw driver
Key to turn on the computer, found in room 310A

Procedure:

1. Turn on/off the following equipment:
   Turn off the manual on/off switch at the mill motor actuator
   (Ratiotrol™ control box)
   Switch on 110VAC power circuit breaker
   Turn on the computer

2. Attach the sling to the feed end side of the frame supporting the SAG mill. Use a point near the mill weight sensor. attach the crane to the sling and lift the mill off of the mill weight sensor. Weigh the steel plate .

3. The computer control program starts automatically when the computer is turned on. The startup parameter screen will be displayed first (displays are shown in appendix B). Hit the <F9> key to go to the SENSOR Calibration display (CALIB). The display shows the values of all of the signals brought into or sent from the computer by the 60cm circuit. They are shown with their tag names (listed in appendix H).

4. Look at the value of AI-WM tag on the CALIB screen. It should indicate -279.45 (Kg). If it does not use the Jewellers screwdriver to adjust the zero on the ACTION PAK™ module in the signal panel box labeled "mill weight" until it does. Next, lower the SAG mill unto the mill weight sensor and adjust the span until the tag value is 0Kg. Lift and lower the mill to repeat the adjustments until the measurements are correct. Check the calibration by placing the steel plate on the feed end of the SAG mill frame over the mill weight sensor. The indicated weight should be within three percent of it's actual weight.

5. Continue with the circuit calibration by following the instructions in the other sections or if you wish to make a run fill in the requested information and hit <F2> To leave the system hit <F10>. You will go to the main menu. Hitting the <F10> key again will prompt the user for the shut down code. Then hit <alt><Y> to exit to DOS. Turn on/off the following equipment:
   Turn on the manual on/off switch at the mill motor actuator
   (Ratiotrol™ control box)
   Switch off 110VAC power circuit breaker
   Turn off the computer
   Clean up

Appendix E:
Drawings

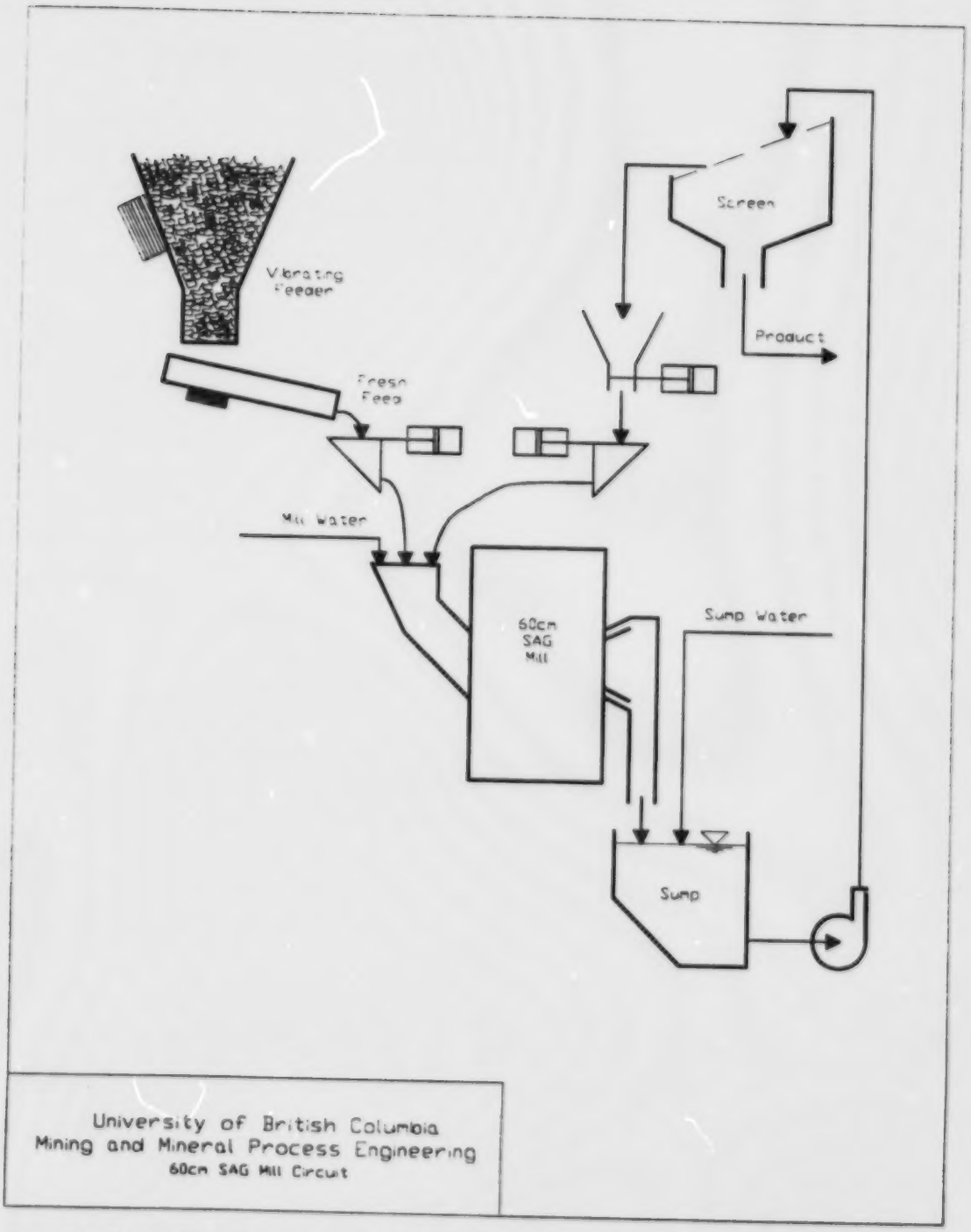


Figure E1. Simplified Flowsheet for the 60cm SAG Mill Circuit at the University of British Columbia.

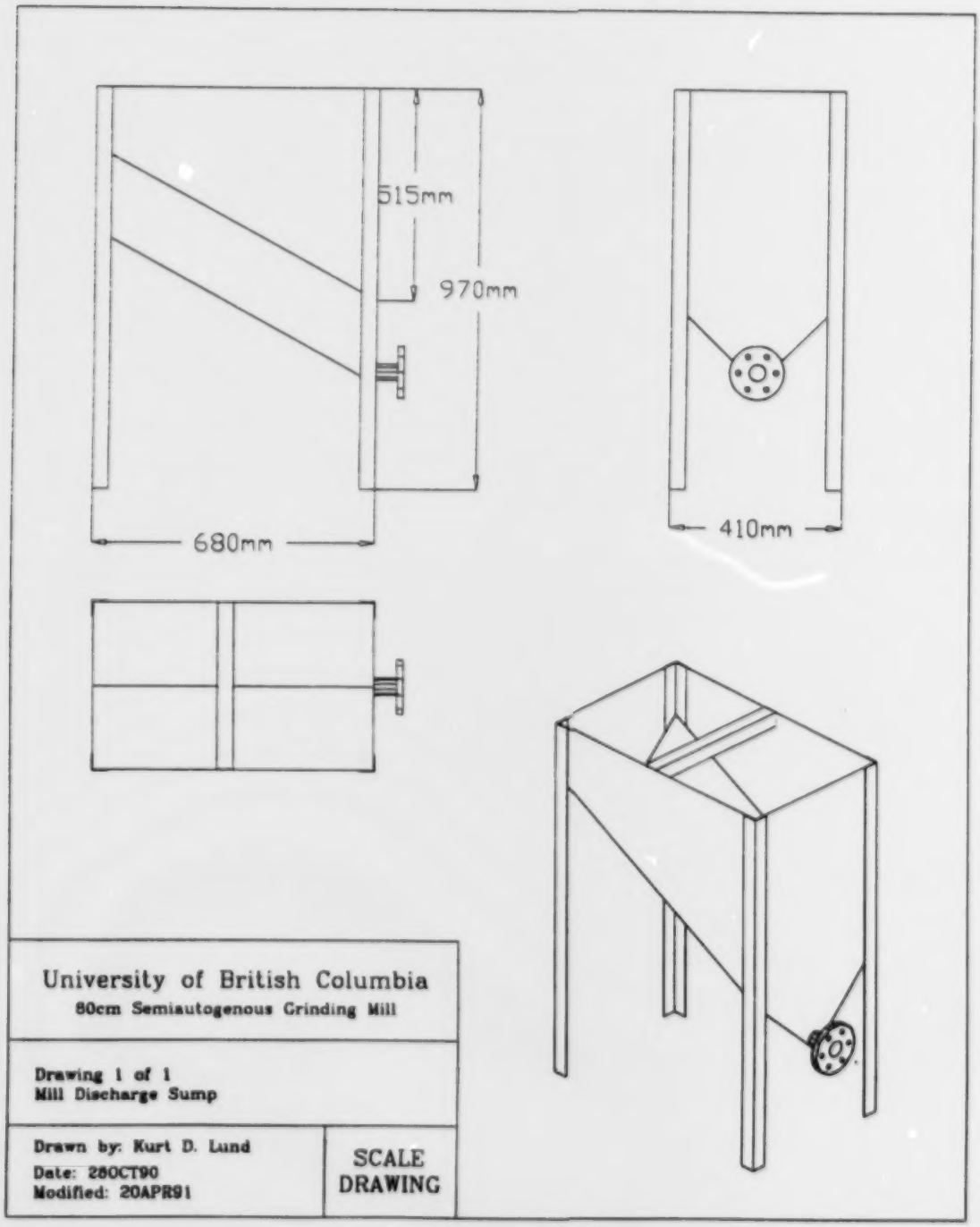


Figure E2. Plan and Elevation of the Sump for the 60cm SAG Mill Circuit at the University of British Columbia.

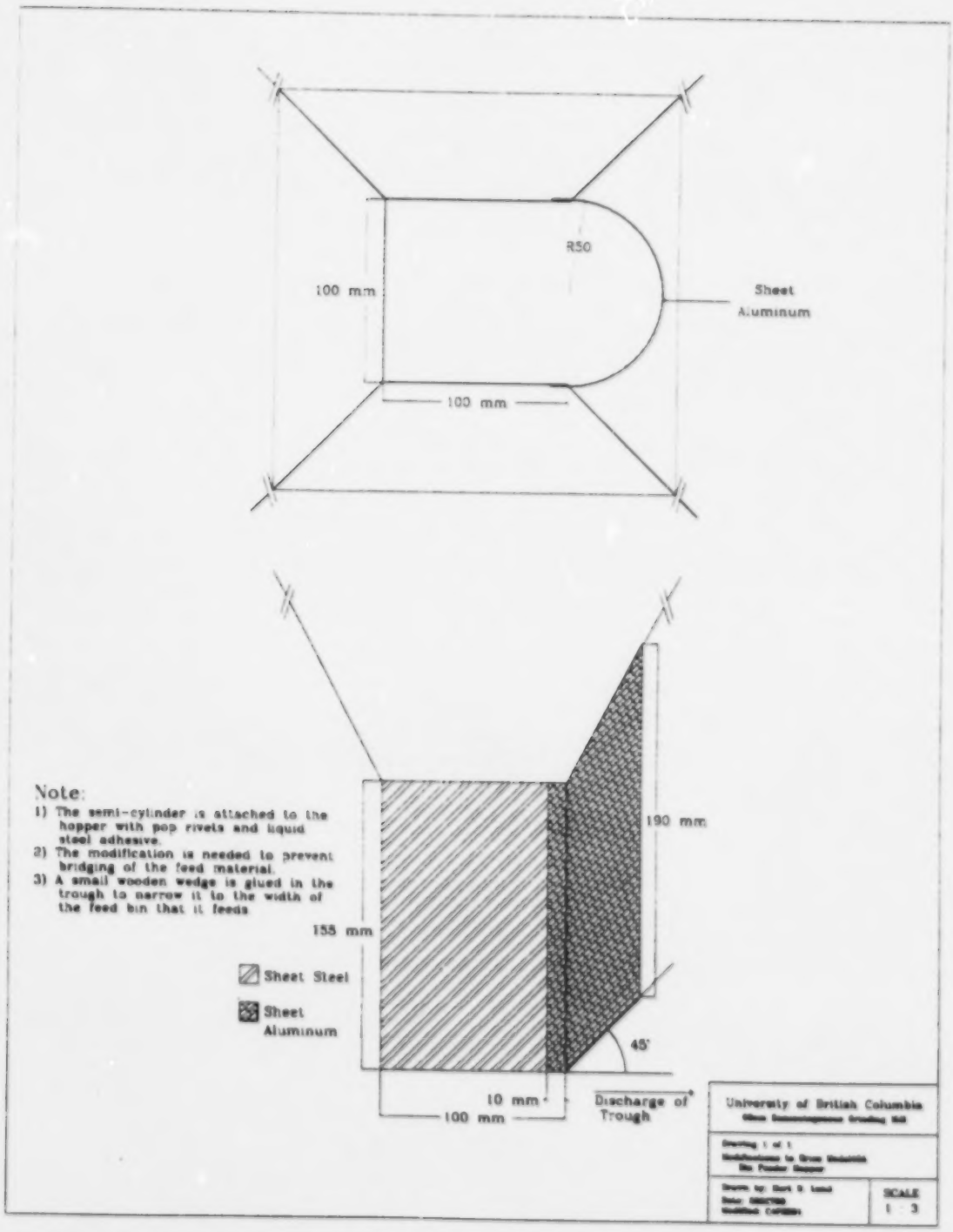


Figure E3. Modifications of the Vibrating Feeder for the 60cm SAG Mill Circuit at the University of British Columbia.

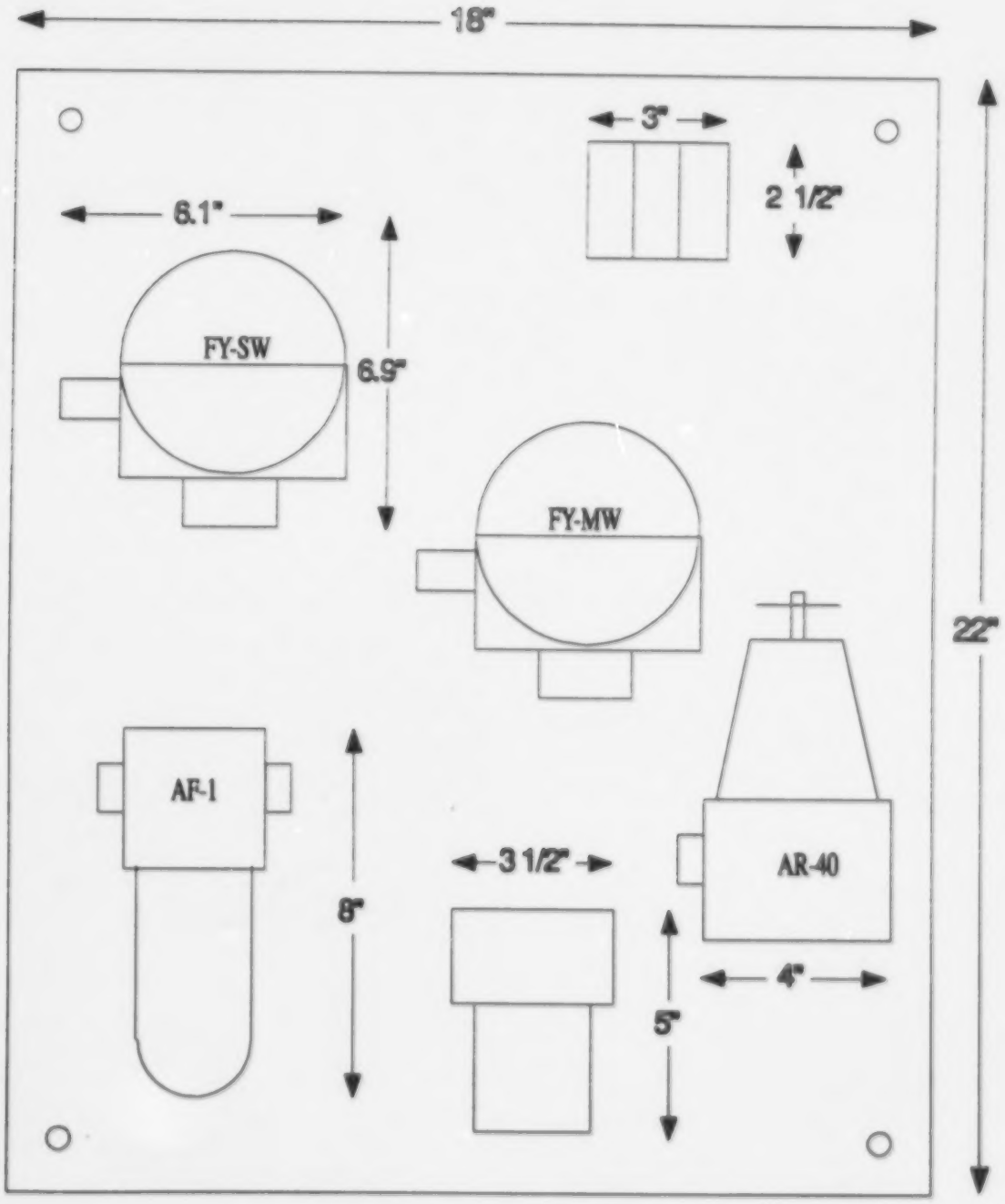


Figure E4. Air Panel Box Layout for the 60cm SAG Mill Circuit at the University of British Columbia.

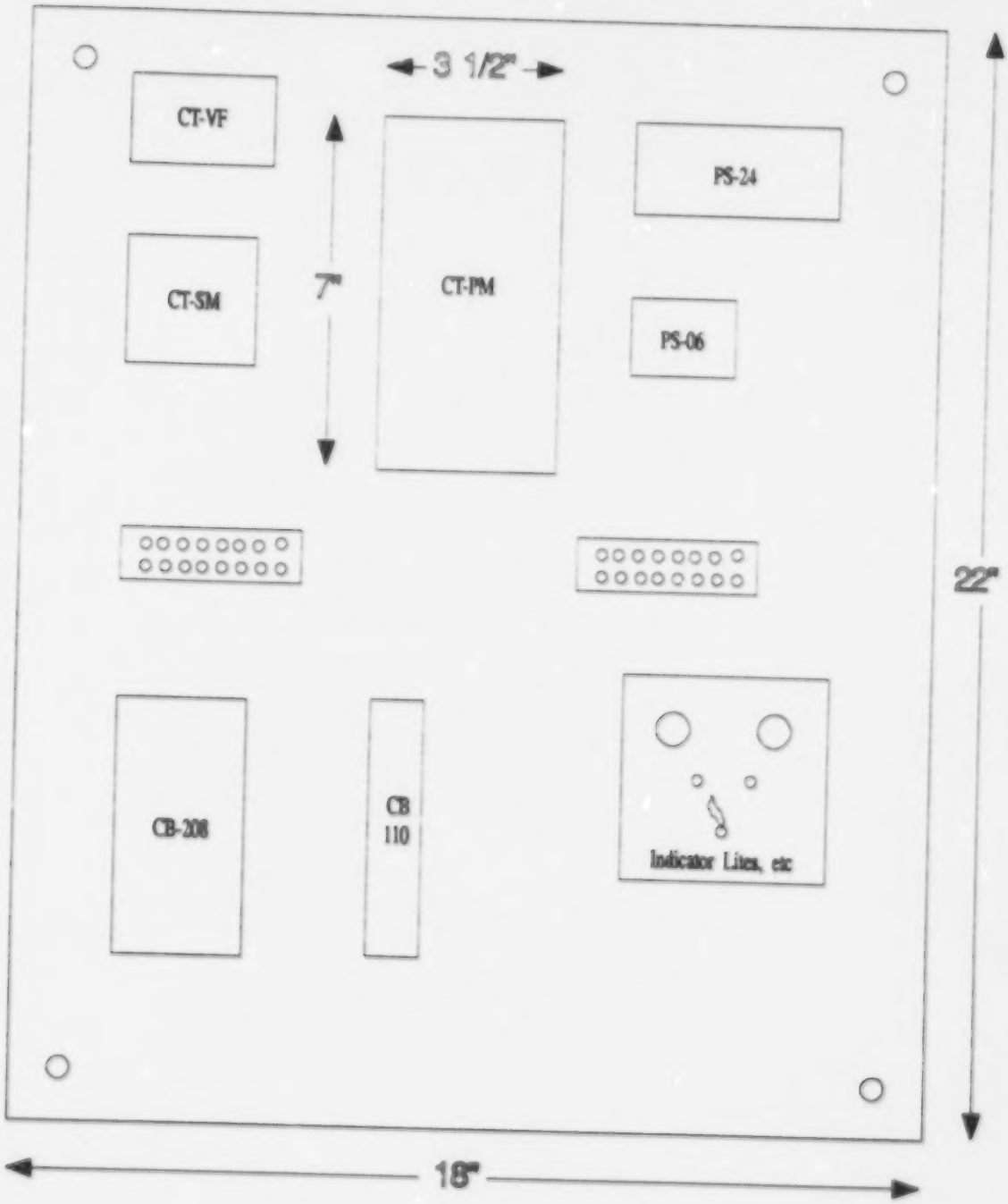


Figure E5. Power Panel Box Layout for the 60cm SAG Mill Circuit at the University of British Columbia.

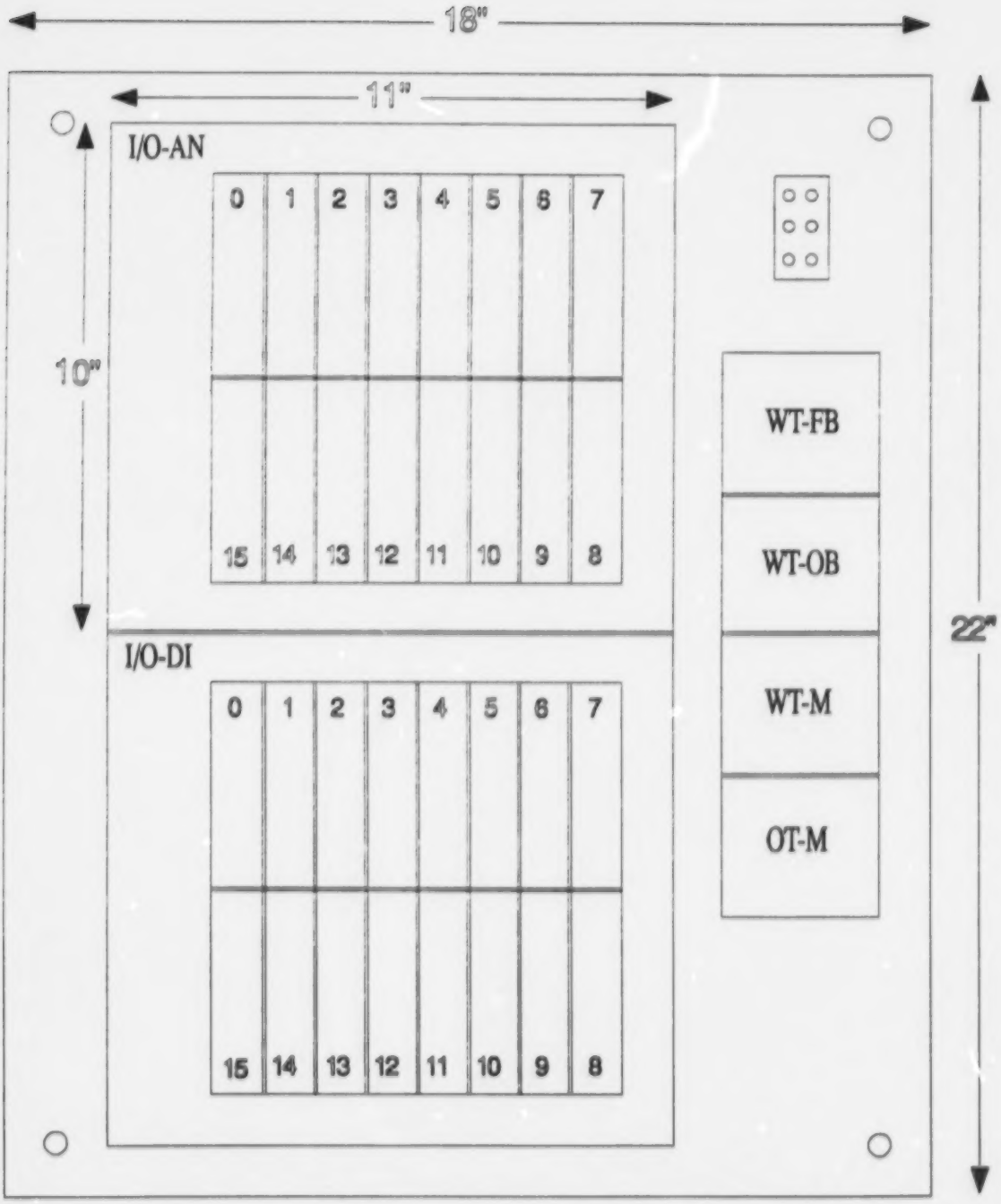


Figure E6. Sensor and Signal Panel Box Layout for the 60cm SAG Mill Circuit at the University of British Columbia.

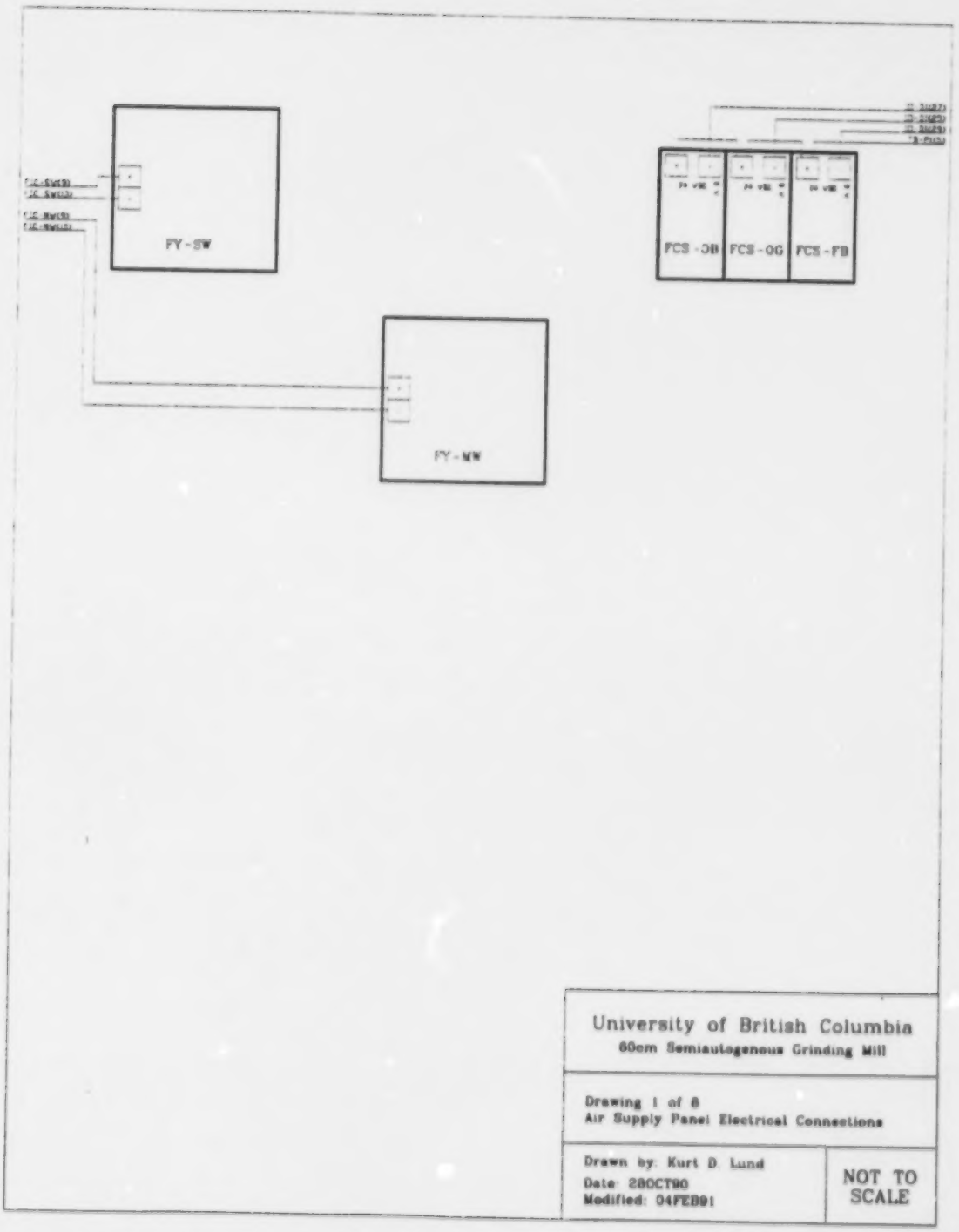


Figure E7. Air Supply Panel Electrical Connections for the 60cm SAG Mill Circuit at the University of British Columbia.

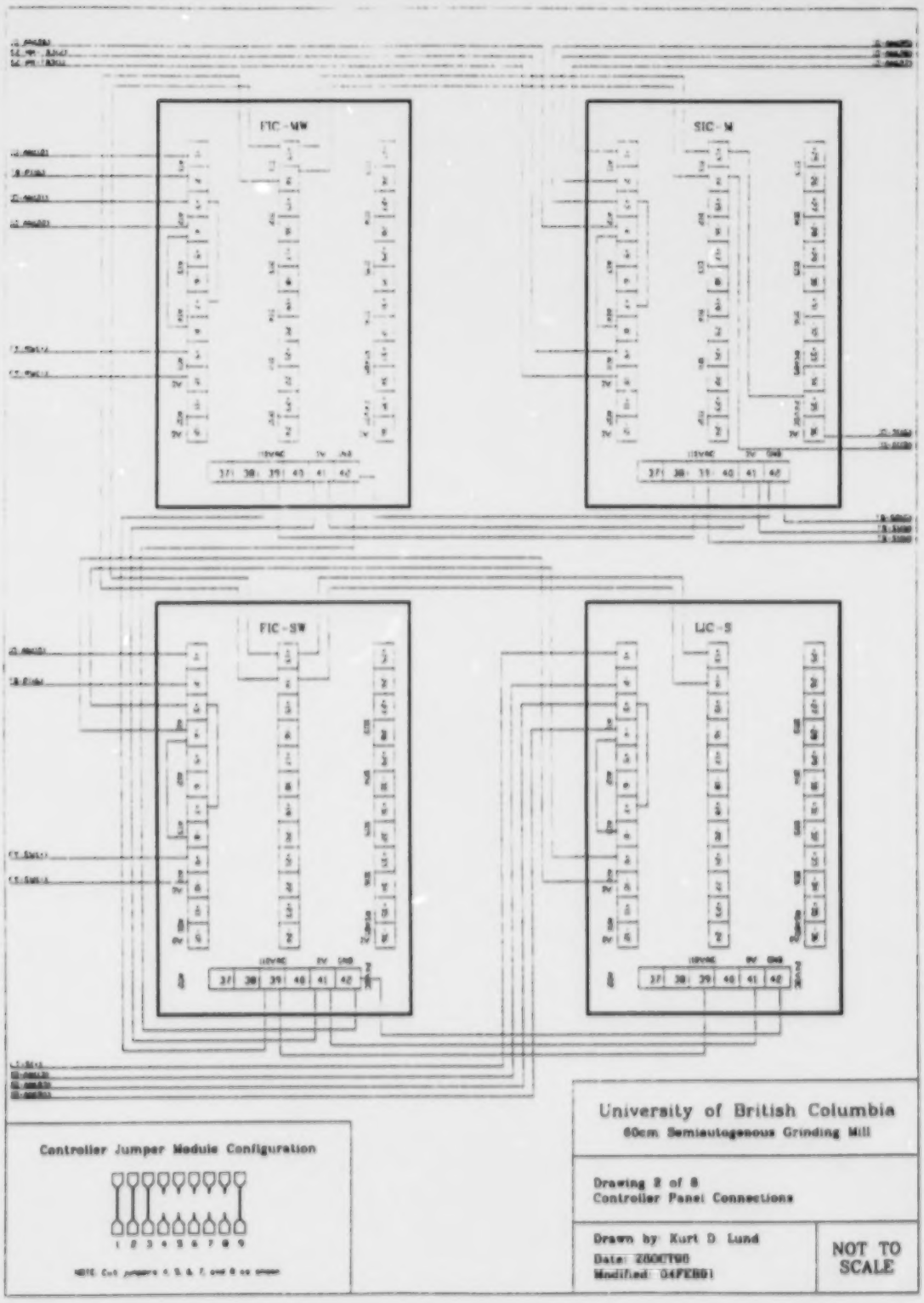


Figure E8. Controller Panel Electrical Connections for the 60cm SAG Mill Circuit at the University of British Columbia.

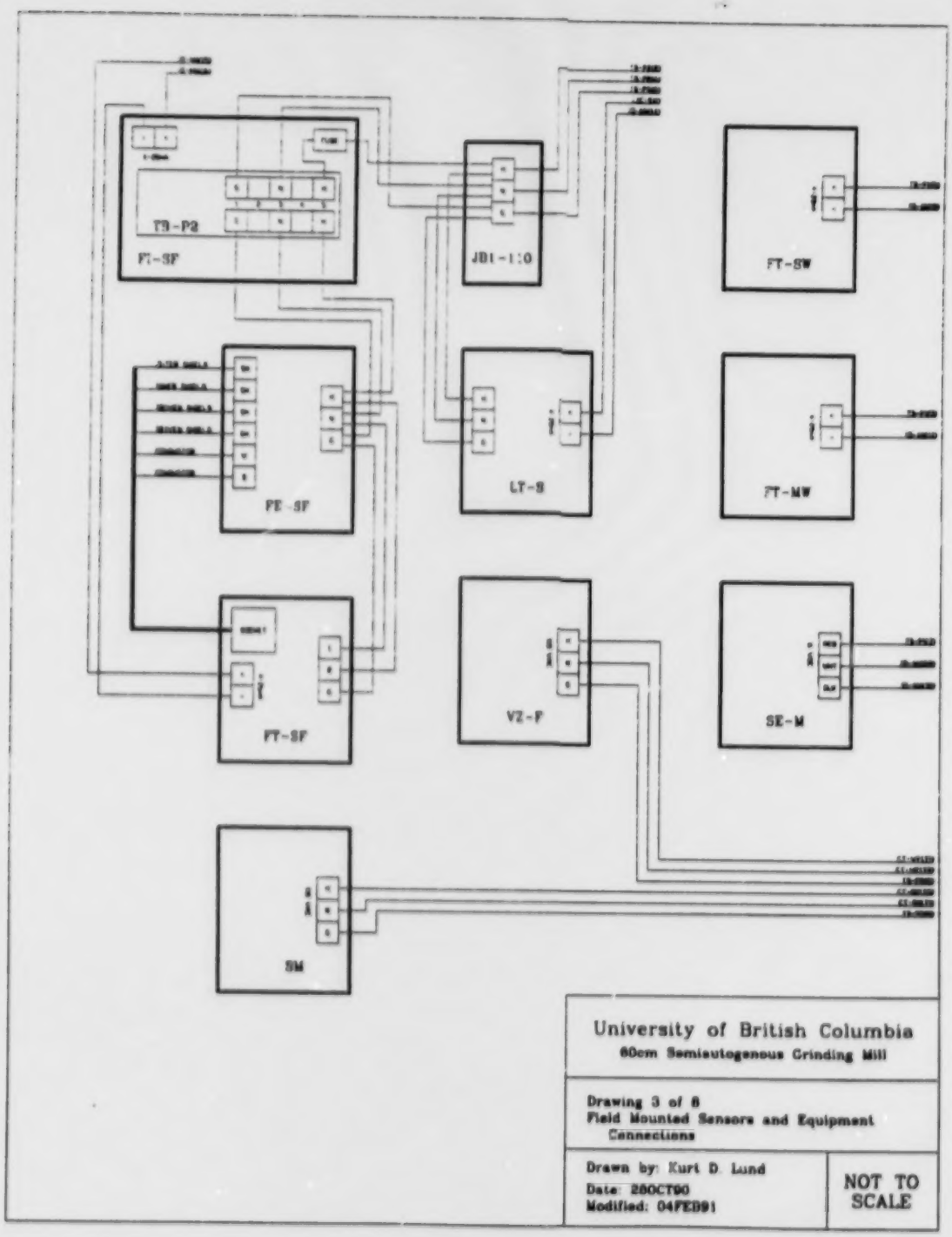


Figure E9. Field Mounted Sensors and Equipment Electrical Connections for the 60cm SAG Mill Circuit at the University of British Columbia.

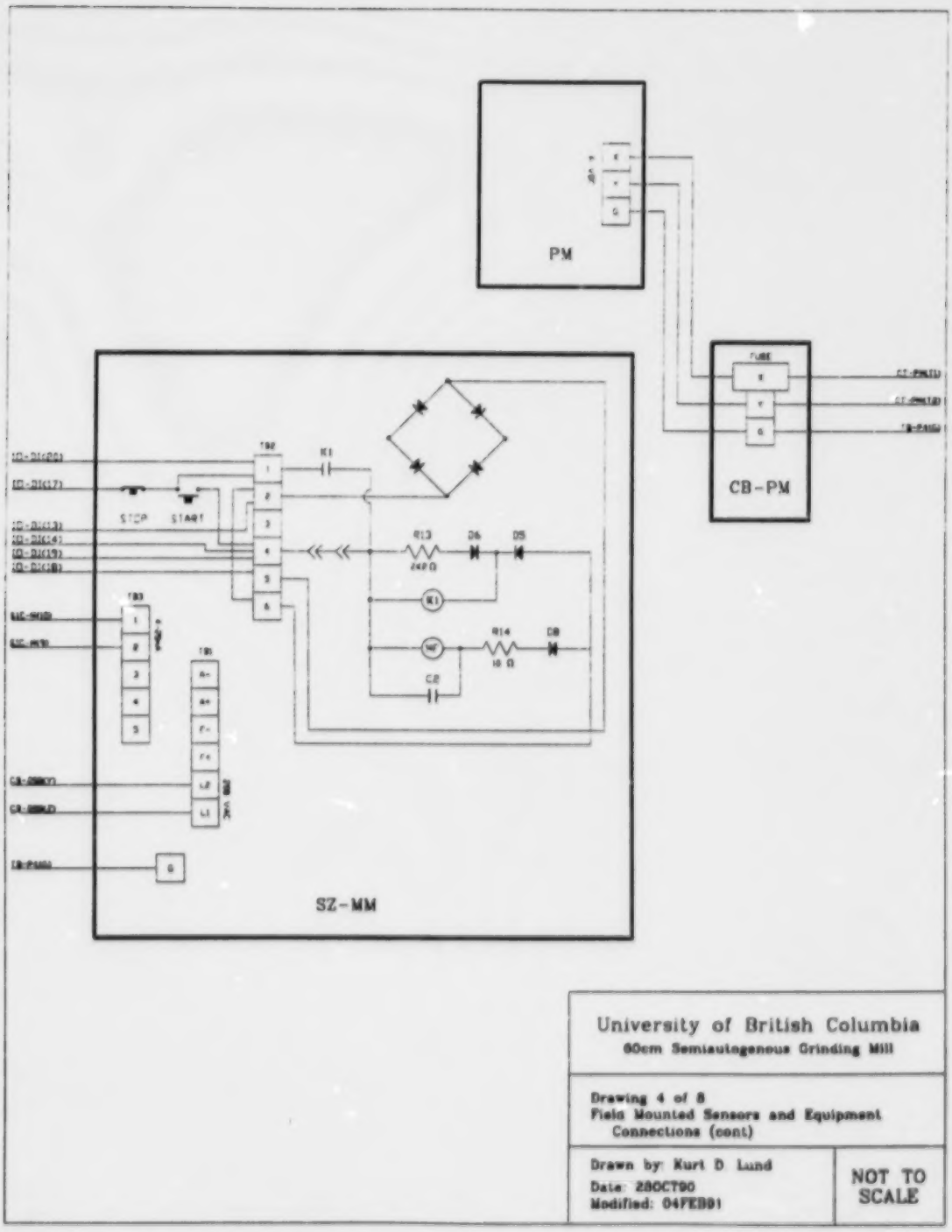


Figure E9 (cont). Field Mounted Sensors and Equipment Electrical Connections for the 60cm SAG Mill Circuit at the University of British Columbia.

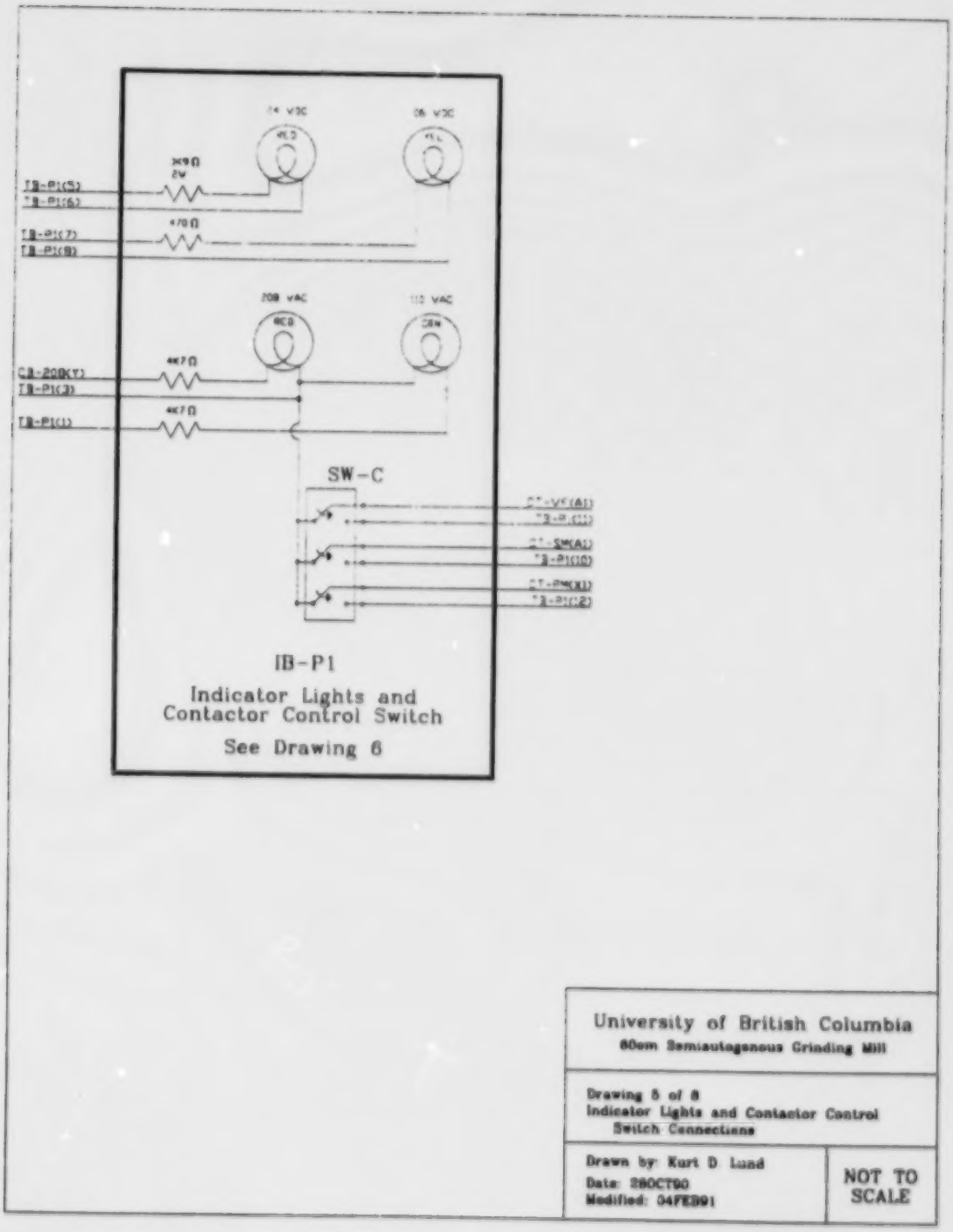


Figure E10. Indicator Lights and Contactor Control Electrical Connections for the 60cm SAG Mill Circuit at the University of British Columbia.

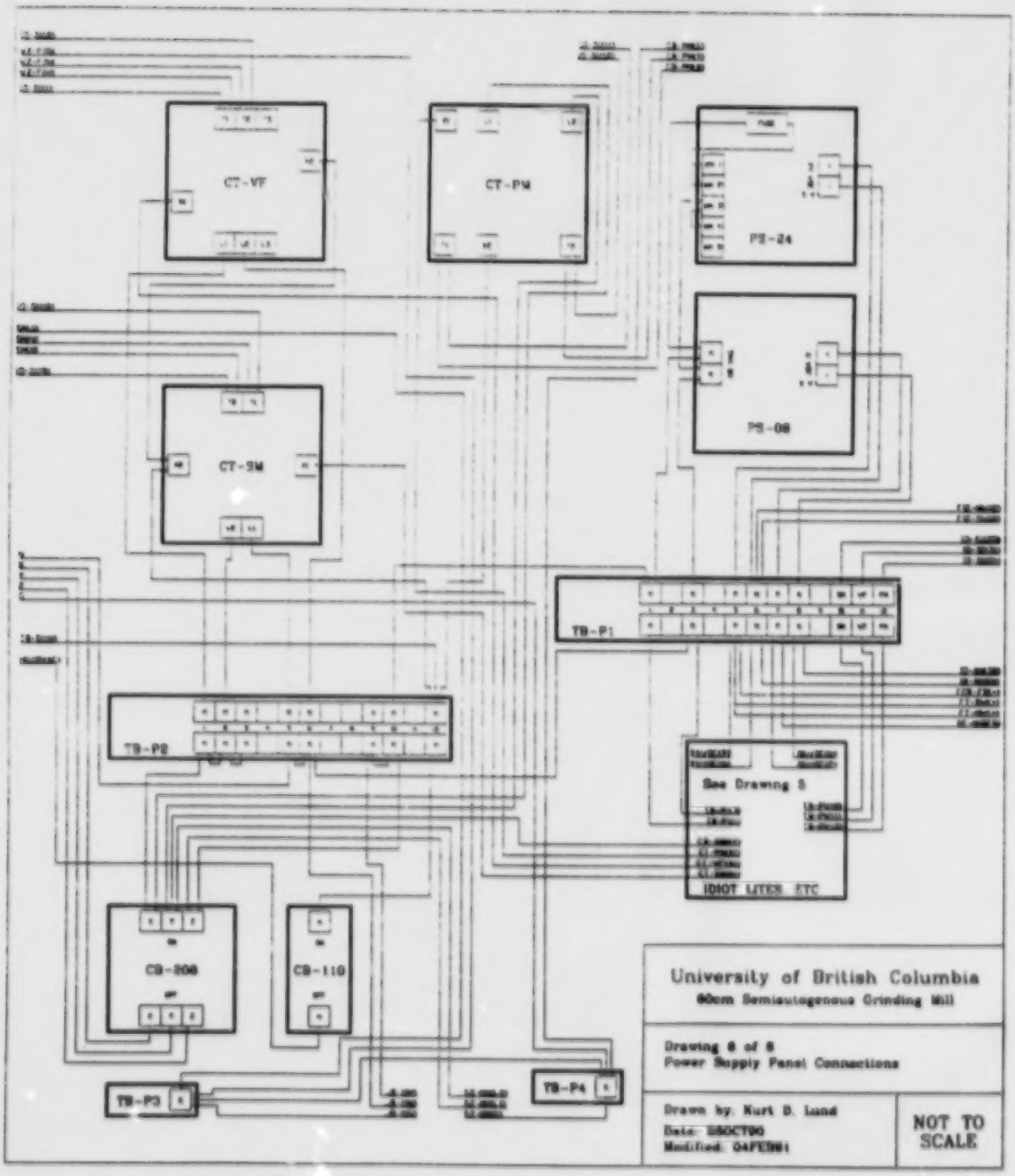


Figure E11. Power Supply Panel Electrical Connections for the 60cm SAG Mill Circuit at the University of British Columbia.

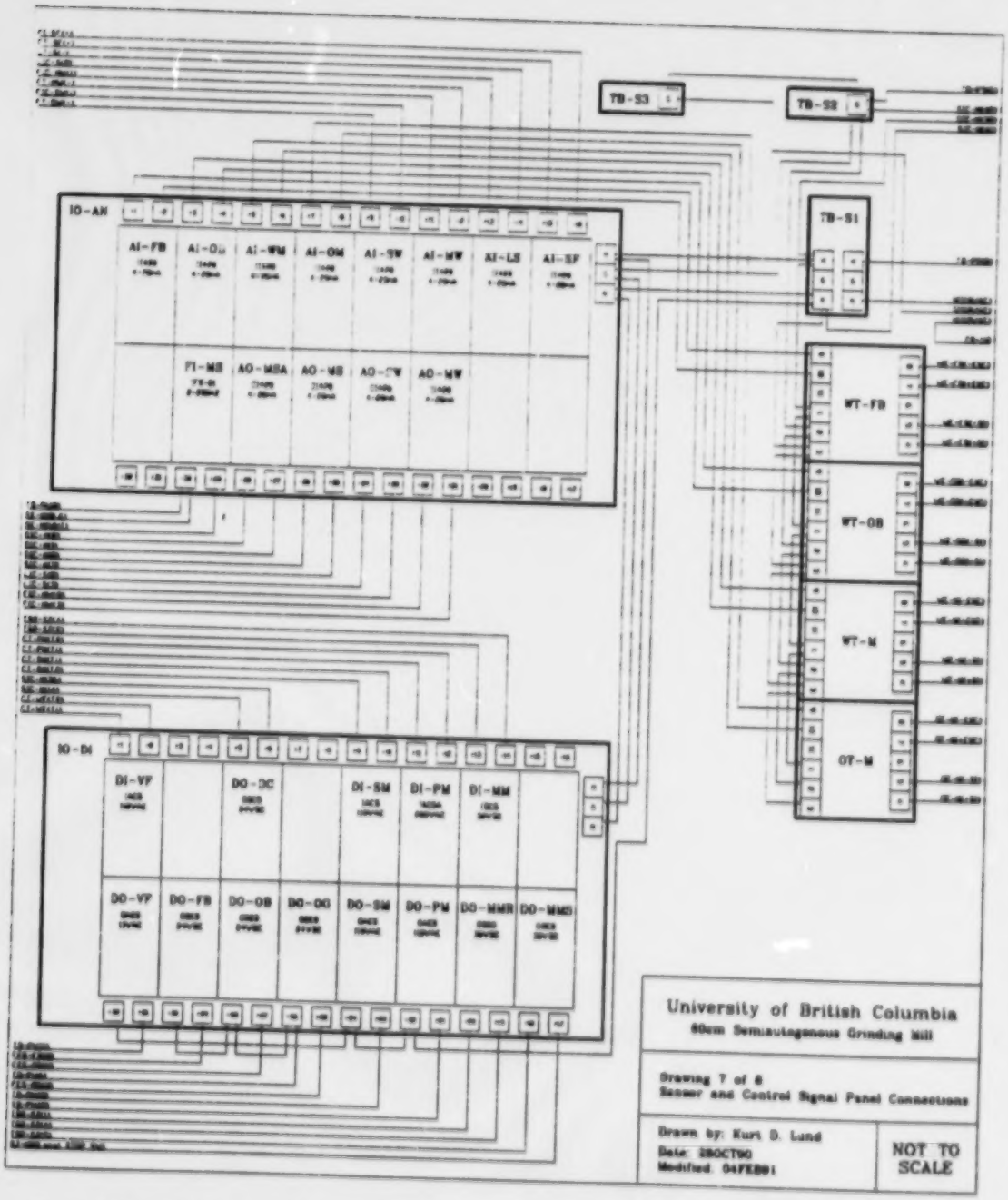


Figure E12. Sensor and Control Signal Panel Electrical Connections for the 60cm SAG Mill Circuit at the University of British Columbia.

Notes:

1) Tag names are listed in Appendix F of the Operator's Manual.
2) For technical information please refer to the manuals stored under the computer screen at the SAG mill.
3) All signal wires are shielded and grounded. These ground connections are not shown. The shield ground is separate from the ground used for the power connections.
4) There are two AC power sources for the circuit, both are distributed from the power panel (drawing No. 6). They are: a) the three phase 208VAC, on wires N,X,Y,Z,G and b) a single phase 120VAC, on H(110VAC). It has a separate neutral and ground to isolate the input output gear in the signal panel box (drawing No. 7) from the vibrating feeder.
5) All motors and the vibrating feeder have local start/stop switches.

University of British Columbia
60cm Semiautogenous Grinding Mill

Drawing 8 of 8
Notes

Drawn by: Kurt D. Lund
Date: 28OCT90
Modified: 04FEB91

NOT TO SCALE

Figure E13. Notes for the Electrical Connections for the 60cm SAG Mill Circuit at the University of British Columbia.

Appendix F:
Tag Name List(s)

Table F1. FIX ACE™ Control Software Tag Name List

TYPE: AI

TAG..... AIF-FB
DV-DEVICE..... OPT
HT-H/W OPTIONS.
IO-ADDR..... 1:82:0
SC-SIG COND.... LIN
EL-LO EGU..... -382.0
EH-HI EGU..... 518.0
ET-EGU TAG..... g
ST-SCAN TIME... 1
SM-SMOOTHING... 0
IS-INIT SCAN... ON
DESC.... weight signal from fresh feed bin
LL-LO LO ALM... -382.0
AL-LO ALARM.... -382.0
AH-HI ALARM.... 518.0
HH-HI HI ALM... 518.0
RC-ROC ALM..... 0.0
DB-DEAD BAND... 0.0
AP-ALM PRI..... H
AD-ALM DEST.... HF
AE-ALM ENABLE.. ENABLE
CC-ALM CONTACT.
CM-CC ALM MODE. ANY
NX-NEXT BLK.... TR-FB

TAG..... AIF-OB
DV-DEVICE..... OPT
HT-H/W OPTIONS.
IO-ADDR..... 1:82:1
SC-SIG COND.... LIN
EL-LO EGU..... -368.0
EH-HI EGU..... 357.0
ET-EGU TAG..... g
ST-SCAN TIME... 1
SM-SMOOTHING... 0
IS-INIT SCAN... ON
DESC.... weight signal from oversize bin
LL-LO LO ALM... -368.0
AL-LO ALARM.... -368.0
AH-HI ALARM.... 357.0
HH-HI HI ALM... 357.0
RC-ROC ALM..... 0.0
DB-DEAD BAND... 0.0
AP-ALM PRI..... H
AD-ALM DEST.... HF
AE-ALM ENABLE.. ENABLE
CC-ALM CONTACT.
CM-CC ALM MODE. ANY
NX-NEXT BLK.... TR-OB

TAG..... AIF-WM
DV-DEVICE..... OPT
HT-H/W OPTIONS.
IO-ADDR..... 1:82:2
SC-SIG COND.... LIN
EL-LO EGU..... -279.45
EH-HI EGU..... 168.15
ET-EGU TAG..... Kg
ST-SCAN TIME... 10
SM-SMOOTHING... 15
IS-INIT SCAN... ON
DESC.... weight signal from mill
LL-LO LO ALM... -279.45
AL-LO ALARM.... -279.45
AH-HI ALARM.... 168.15
HH-HI HI ALM... 168.15
RC-ROC ALM..... 0.00
DB-DEAD BAND... 0.00
AP-ALM PRI..... H
AD-ALM DEST.... HF
AE-ALM ENABLE.. ENABLE
CC-ALM CONTACT.
CM-CC ALM MODE. ANY
NX-NEXT BLK.... TR-WM

TAG..... AIF-OM
DV-DEVICE..... OPT
HT-H/W OPTIONS.
IO-ADDR..... 1:82:3
SC-SIG COND.... LIN
EL-LO EGU..... 0.0
EH-HI EGU..... 30.0
ET-EGU TAG..... Kg.m
ST-SCAN TIME... 10
SM-SMOOTHING... 15
IS-INIT SCAN... ON
DESC.... torque signal from mill
LL-LO LO ALM... 0.0
AL-LO ALARM.... 0.0
AH-HI ALARM.... 30.0
HH-HI HI ALM... 30.0
RC-ROC ALM..... 0.0
DB-DEAD BAND... 0.0
AP-ALM PRI..... H
AD-ALM DEST.... HF
AE-ALM ENABLE.. ENABLE
CC-ALM CONTACT.
CM-CC ALM MODE. ANY
NX-NEXT BLK.... CA-JM

TAG..... AIF-SW
DV-DEVICE..... OPT
HT-H/W OPTIONS.
IO-ADDR..... 1:82:4
SC-SIG COND.... SQR
EL-LO EGU..... 0.0
EH-HI EGU..... 110.0
ET-EGU TAG..... lpm
ST-SCAN TIME... 2
SM-SMOOTHING... 15
IS-INIT SCAN... ON
DESC.... flow signal from sump water dp cell
LL-LO LO ALM... 0.0
AL-LO ALARM.... 10.1
AH-HI ALARM.... 110.0
HH-HI HI ALM... 110.0
RC-ROC ALM..... 0.0
DB-DEAD BAND... 0.0
AP-ALM PRI..... H
AD-ALM DEST.... HF
AE-ALM ENABLE.. ENABLE
CC-ALM CONTACT.
CM-CC ALM MODE. ANY
NX-NEXT BLK.... TR-SW

TAG..... AIF-LS
DV-DEVICE..... OPT
HT-H/W OPTIONS.
IO-ADDR..... 1:82:6
SC-SIG COND.... LIN
EL-LO EGU..... 0.0
EH-HI EGU..... 100.0
ET-EGU TAG..... %
ST-SCAN TIME... 10
SM-SMOOTHING... 0
IS-INIT SCAN... ON
DESC.... level signal from sump
LL-LO LO ALM... 0.0
AL-LO ALARM.... 10.0
AH-HI ALARM.... 100.0
HH-HI HI ALM... 100.0
RC-ROC ALM..... 0.0
DB-DEAD BAND... 10.0
AP-ALM PRI..... H
AD-ALM DEST.... HF
AE-ALM ENABLE.. ENABLE
CC-ALM CONTACT.
CM-CC ALM MODE. ANY
NX-NEXT BLK.... TR-LS

TAG..... AIF-MW
DV-DEVICE..... OPT
HT-H/W OPTIONS.
IO-ADDR..... 1:82:5
SC-SIG COND.... SQR
EL-LO EGU..... 0.000
EH-HI EGU..... 0.900
ET-EGU TAG..... lpm
ST-SCAN TIME... 2
SM-SMOOTHING... 0
IS-INIT SCAN... ON
DESC.... flow signal from mill water dp cell
LL-LO LO ALM... 0.000
AL-LO ALARM.... 0.000
AH-HI ALARM.... 0.900
HH-HI HI ALM... 0.900
RC-ROC ALM..... 0.000
DB-DEAD BAND... 0.103
AP-ALM PRI..... H
AD-ALM DEST.... HF
AE-ALM ENABLE.. ENABLE
CC-ALM CONTACT.
CM-CC ALM MODE. ANY
NX-NEXT BLK.... TR-MW

TAG..... AIF-SF
DV-DEVICE..... OPT
HT-H/W OPTIONS.
IO-ADDR..... 1:82:7
SC-SIG COND.... LIN
EL-LO EGU..... 0.0
EH-HI EGU..... 110.0
ET-EGU TAG..... lpm
ST-SCAN TIME... 10
SM-SMOOTHING... 10
IS-INIT SCAN... ON
DESC.. flow signal from mag flow (screen feed)
LL-LO LO ALM... 0.0
AL-LO ALARM.... 80.7
AH-HI ALARM.... 110.0
HH-HI HI ALM... 110.0
RC-ROC ALM..... 0.0
DB-DEAD BAND... 0.0
AP-ALM PRI..... H
AD-ALM DEST.... HF
AE-ALM ENABLE.. ENABLE
CC-ALM CONTACT.
CM-CC ALM MODE. ANY
NX-NEXT BLK.... TR-SF

TAG..... AID-FF
DV-DEVICE..... DUMMY
HT-H/W OPTIONS.
IO-ADDR..... 0
SC-SIG COND....
EL-LO EGU..... 0
EH-HI EGU..... 2400
ET-EGU TAG..... gpm
ST-SCAN TIME... 2
SM-SMOOTHING... 0
IS-INIT SCAN... ON
DESC.... dummy analog input for fresh feed rate
LL-LO LO ALM... 0
AL-LO ALARM.... 0
AH-HI ALARM.... 2400
HH-HI HI ALM... 2400
RC-ROC ALM..... 0
DB-DEAD BAND... 240
AP-ALM PRI..... L
AD-ALM DEST.... HF
AE-ALM ENABLE.. DISABLE
CC-ALM CONTACT.
CM-CC ALM MODE. ANY
NX-NEXT BLK.... TR-FF

TAG..... AID-OS
DV-DEVICE..... DUMMY
HT-H/W OPTIONS.
IO-ADDR..... 0
SC-SIG COND....
EL-LO EGU..... 0
EH-HI EGU..... 1000
ET-EGU TAG..... gpm
ST-SCAN TIME... 2
SM-SMOOTHING... 0
IS-INIT SCAN... ON
DESC.... dummy input for calc. screen o/s flow
LL-LO LO ALM... 0
AL-LO ALARM.... 0
AH-HI ALARM.... 1000
HH-HI HI ALM... 1000
RC-ROC ALM..... 0
DB-DEAD BAND... 100
AP-ALM PRI..... L
AD-ALM DEST.... HF
AE-ALM ENABLE.. DISABLE
CC-ALM CONTACT.
CM-CC ALM MODE. ANY
NX-NEXT BLK.... TR-OS

TAG..... AIF-MS
DV-DEVICE..... OPT
HT-H/W OPTIONS.
IO-ADDR..... 1:82:14
SC-SIG COND.... LIN
EL-LO EGU..... 0.0
EH-HI EGU..... 99.0
ET-EGU TAG..... rpm
ST-SCAN TIME... 2
SM-SMOOTHING... 0
IS-INIT SCAN... ON
DESC... frequency signal from mill speed sensor
LL-LO LO ALM... 0.0
AL-LO ALARM.... 0.0
AH-HI ALARM.... 99.0
HH-HI HI ALM... 99.0
RC-ROC ALM..... 0.0
DB-DEAD BAND... 9.9
AP-ALM PRI..... H
AD-ALM DEST.... HF
AE-ALM ENABLE.. ENABLE
CC-ALM CONTACT.
CM-CC ALM MODE. ANY
NX-NEXT BLK.... RB-MS

TAG..... SP-MS
DV-DEVICE..... DUMMY
HT-H/W OPTIONS.
IO-ADDR..... 60.00
SC-SIG COND....
EL-LO EGU..... 0.00
EH-HI EGU..... 107.41
ET-EGU TAG..... %CRT
ST-SCAN TIME... 2
SM-SMOOTHING... 0
IS-INIT SCAN... ON
DESC.... mill speed setpoint
LL-LO LO ALM... 0.00
AL-LO ALARM.... 0.00
AH-HI ALARM.... 100.00
HH-HI HI ALM... 107.41
RC-ROC ALM..... 0.00
DB-DEAD BAND... 10.74
AP-ALM PRI..... L
AD-ALM DEST.... HF
AE-ALM ENABLE.. DISABLE
CC-ALM CONTACT.
CM-CC ALM MODE. ANY
NX-NEXT BLK.... TR-SPMS

TAG..... SP-LS
DV-DEVICE..... DUMMY
HT-H/W OPTIONS.
IO-ADDR..... 30.0
SC-SIG COND....
EL-LO EGU..... 0.0
EH-HI EGU..... 100.0
ET-EGU TAG..... %
ST-SCAN TIME... 10
SM-SMOOTHING... 0
IS-INIT SCAN... ON
DESC.... level setpoint
LL-LO LO ALM... 0.0
AL-LO ALARM.... 0.0
AH-HI ALARM.... 100.0
HH-HI HI ALM... 100.0
RC-ROC ALM..... 0.0
DB-DEAD BAND... 10.0
AP-ALM PRI..... L
AD-ALM DEST.... HF
AE-ALM ENABLE.. DISABLE
CC-ALM CONTACT.
CM-CC ALM MODE. ANY
NX-NEXT BLK.... TR-SPLS

TAG..... SP-WM
DV-DEVICE..... DUMMY
HT-H/W OPTIONS.
IO-ADDR..... 40.00
SC-SIG COND....
EL-LO EGU..... -279.45
EH-HI EGU..... 168.15
ET-EGU TAG..... Kg
ST-SCAN TIME... 10
SM-SMOOTHING... 0
IS-INIT SCAN... ON
DESC.... mill weight setpoint
LL-LO LO ALM... -279.45
AL-LO ALARM.... -279.45
AH-HI ALARM.... 168.15
HH-HI HI ALM... 168.15
RC-ROC ALM..... 0.00
DB-DEAD BAND... 0.00
AP-ALM PRI..... H
AD-ALM DEST.... HF
AE-ALM ENABLE.. ENABLE
CC-ALM CONTACT.
CM-CC ALM MODE. ANY
NX-NEXT BLK.... TR-SPWM

TAG..... AID-MSA
DV-DEVICE..... DUMMY
HT-H/W OPTIONS.
IO-ADDR..... 0.00
SC-SIG COND....
EL-LO EGU..... 0.00
EH-HI EGU..... 107.41
ET-EGU TAG..... %CRT
ST-SCAN TIME... 5
SM-SMOOTHING... 0
IS-INIT SCAN... ON
DESC.... dummy connection
LL-LO LO ALM... 0.00
AL-LO ALARM.... 0.00
AH-HI ALARM.... 107.41
HH-HI HI ALM... 107.41
RC-ROC ALM..... 0.00
DB-DEAD BAND... 10.74
AP-ALM PRI..... L
AD-ALM DEST.... TH
AE-ALM ENABLE.. DISABLE
CC-ALM CONTACT.
CM-CC ALM MODE. ANY
NX-NEXT BLK.... AOF-MSA

TAG..... AID-JMZ
DV-DEVICE..... DUMMY
HT-H/W OPTIONS.
IO-ADDR..... 0.00
SC-SIG COND....
EL-LO EGU..... 0.00
EH-HI EGU..... 300.00
ET-EGU TAG..... W
ST-SCAN TIME... 5
SM-SMOOTHING... 0
IS-INIT SCAN... OFF
DESC.... Dummy for empty mill power correction
LL-LO LO ALM... 0.00
AL-LO ALARM.... 0.00
AH-HI ALARM.... 300.00
HH-HI HI ALM... 300.00
RC-ROC ALM..... 0.00
DB-DEAD BAND... 30.00
AP-ALM PRI..... L
AD-ALM DEST.... HF
AE-ALM ENABLE.. DISABLE
CC-ALM CONTACT.
CM-CC ALM MODE. ANY
NX-NEXT BLK.... CA-JMZ

TAG..... AID-MW
DV-DEVICE..... DUMMY
HT-H/W OPTIONS.
IO-ADDR..... 0.00
SC-SIG COND....
EL-LO EGU..... 0.00
EH-HI EGU..... 100.00
ET-EGU TAG..... %
ST-SCAN TIME... 2
SM-SMOOTHING... 0
IS-INIT SCAN... ON
DESC.... dummy to ensure 20% mill water flow
LL-LO LO ALM... 0.00
AL-LO ALARM.... 0.00
AH-HI ALARM.... 100.00
HH-HI HI ALM... 100.00
RC-ROC ALM..... 0.00
DB-DEAD BAND... 10.00
AP-ALM PRI..... L
AD-ALM DEST.... HF
AE-ALM ENABLE.. DISABLE
CC-ALM CONTACT.
CM-CC ALM MODE. ANY
NX-NEXT BLK....

TAG..... AID-WM
DV-DEVICE..... DUMMY
HT-H/W OPTIONS.
IO-ADDR..... -0.13
SC-SIG COND....
EL-LO EGU..... -279.45
EH-HI EGU..... 168.15
ET-EGU TAG..... Kg
ST-SCAN TIME... 250
SM-SMOOTHING... 1
IS-INIT SCAN... ON
DESC.... weight signal from mill
LL-LO LO ALM... -279.45
AL-LO ALARM.... -279.45
AH-HI ALARM.... 168.15
HH-HI HI ALM... 168.15
RC-ROC ALM. ... 0.00
DB-DEAD BAND... 0.00
AP-ALM PRI..... H
AD-ALM DEST.... HF
AE-ALM ENABLE.. ENABLE
CC-ALM CONTACT.
CM-CC ALM MODE. ANY
NX-NEXT BLK.... PI-WM

TAG..... AID-WR
DV-DEVICE..... DUMMY
HT-H/W OPTIONS.
IO-ADDR..... 0.600
SC-SIG COND....
EL-LO EGU..... 0.000
EH-HI EGU..... 1.000
ET-EGU TAG.....
ST-SCAN TIME... 2
SM-SMOOTHING... 0
IS-INIT SCAN... ON
DESC.... water to solid ratio
LL-LO LO ALM... 0.000
AL-LO ALARM.... 0.000
AH-HI ALARM.... 1.000
HH-HI HI ALM... 1.000
RC-ROC ALM..... 0.000
DB-DEAD BAND... 0.100
AP-ALM PRI..... L
AD-ALM DEST.... HF
AE-ALM ENABLE.. DISABLE
CC-ALM CONTACT.
CM-CC ALM MODE. ANY
NX-NEXT BLK....

TYPE: AO

TAG..... AOF-MW
DV-DEVICE..... OPT
HT-H/W OPTIONS.
IO-ADDR..... 1:82:10
SC-SIG COND....
EL-LO EGU..... 0.00
EH-HI EGU..... 100.00
ET-EGU TAG..... %
OR-OUT REVERSE. N
CS-COLD START.. 0.00
DESC.... mill water flow signal to control valve
LL-LO OP LIMIT. 0.00
LH-HI OP LIMIT. 100.00
LR-RATE LIMIT.. 100.00
NX-NEXT BLK....
CP-COPY TO.....

TAG..... AOD-OBAT
DV-DEVICE..... DUMMY
HT-H/W OPTIONS.
IO-ADDR.....
SC-SIG COND....
EL-LO EGU..... -350
EH-HI EGU..... 375
ET-EGU TAG..... g
OR-OUT REVERSE. N
CS-COLD START.. 100
DESC.... desired oversize batch size
LL-LO OP LIMIT. -350
LH-HI OP LIMIT. 375
LR-RATE LIMIT.. 725
NX-NEXT BLK....
CP-COPY TO.....

TAG..... AOF-MS
DV-DEVICE..... OPT
HT-H/W OPTIONS.
IO-ADDR..... 1:82:12
SC-SIG COND....
EL-LO EGU..... 0.00
EH-HI EGU..... 100.00
ET-EGU TAG..... %
OR-OUT REVERSE. N
CS-COLD START.. 0.00
DESC.... mill speed signal to ratiotrol
LL-LO OP LIMIT. 0.00
LH-HI OP LIMIT. 100.00
LR-RATE LIMIT.. 100.00
NX-NEXT BLK....
CP-COPY TO.....

TAG..... SPO-MS
DV-DEVICE..... DUMMY
HT-H/W OPTIONS.
IO-ADDR.....
SC-SIG COND....
EL-LO EGU..... 0.00
EH-HI EGU..... 107.41
ET-EGU TAG..... %CRT
OR-OUT REVERSE. N
CS-COLD START.. 0.00
DESC.... mill speed setpoint
LL-LO OP LIMIT. 0.00
LH-HI OP LIMIT. 107.41
LR-RATE LIMIT.. 107.41
NX-NEXT BLK.... SPF-MS
CP-COPY TO..... PI-MS

TAG..... AOF-SW
DV-DEVICE..... OPT
HT-H/W OPTIONS.
IO-ADDR..... 1:82:11
SC-SIG COND....
EL-LO EGU..... 0.00
EH-HI EGU..... 100.00
ET-EGU TAG..... %
OR-OUT REVERSE. N
CS-COLD START.. 0.00
DESC... sump water flow signal to control valve
LL-LO OP LIMIT. 0.00
LH-HI OP LIMIT. 90.00
LR-RATE LIMIT.. 100.00
NX-NEXT BLK....
CP-COPY TO.....

TAG..... SPO-LS
DV-DEVICE..... DUMMY
HT-H/W OPTIONS.
IO-ADDR.....
SC-SIG COND....
EL-LO EGU..... 0.0
EH-HI EGU..... 100.0
ET-EGU TAG..... %
OR-OUT REVERSE. N
CS-COLD START.. 0.0
DESC.... level setpoint
LL-LO OP LIMIT. 0.0
LH-HI OP LIMIT. 100.0
LR-RATE LIMIT.. 100.0
NX-NEXT BLK....
CP-COPY TO..... PI-LS

TAG..... SPO-WM
DV-DEVICE..... DUMMY
HT-H/W OPTIONS.
IO-ADDR.....
SC-SIG COND....
EL-LO EGU..... -279.45
EH-HI EGU..... 168.15
ET-EGU TAG..... Kg
OR-OUT REVERSE. N
CS-COLD START.. 0.01
DESC.... mill weight setpoint
LL-LO OP LIMIT. -279.45
LH-HI OP LIMIT. 168.15
LR-RATE LIMIT.. 447.60
NX-NEXT BLK.... CA-MFILL1
CP-COPY TO..... PI-WM

TAG..... AOF-MSA
DV-DEVICE..... DUMMY
HT-H/W OPTIONS.
IO-ADDR.....
SC-SIG COND....
EL-LO EGU..... 0.00
EH-HI EGU..... 107.41
ET-EGU TAG..... %CRT
OR-OUT REVERSE. N
CS-COLD START.. 0.00
DESC.... mill speed output to Fisher controllers
LL-LO OP LIMIT. 0.00
LH-HI OP LIMIT. 107.41
LR-RATE LIMIT.. 107.41
NX-NEXT BLK....
CP-COPY TO.....

TAG..... AOD-MSA
DV-DEVICE..... DUMMY
HT-H/W OPTIONS.
IO-ADDR.....
SC-SIG COND....
EL-LO EGU..... 0.00
EH-HI EGU..... 107.41
ET-EGU TAG..... %CRT
OR-OUT REVERSE. N
CS-COLD START.. 0.00
DESC....
LL-LO OP LIMIT. 0.00
LH-HI OP LIMIT. 107.41
LR-RATE LIMIT.. 107.41
NX-NEXT BLK....
CP-COPY TO.....

TAG..... AOD-JMZ
DV-DEVICE..... DUMMY
HT-H/W OPTIONS.
IO-ADDR.....
SC-SIG COND....
EL-LO EGU..... 0.00
EH-HI EGU..... 300.00
ET-EGU TAG..... W
OR-OUT REVERSE. N
CS-COLD START.. 0.00
DESC.... Dummy for empty mill power correction
LL-LO OP LIMIT. 0.00
LH-HI OP LIMIT. 300.00
LR-RATE LIMIT.. 300.00
NX-NEXT BLK....
CP-COPY TO.....

TAG..... AOD-R1
DV-DEVICE..... DUMMY
HT-H/W OPTIONS.
IO-ADDR.....
SC-SIG COND....
EL-LO EGU..... 0.00
EH-HI EGU..... 100.00
ET-EGU TAG..... PCT
OR-OUT REVERSE. N
CS-COLD START.. 0.00
DESC.... FINAL PRACTICE TEST
LL-LO OP LIMIT. 0.00
LH-HI OP LIMIT. 100.00
LR-RATE LIMIT.. 100.00
NX-NEXT BLK....
CP-COPY TO.....

TAG..... AOD-R2
DV-DEVICE..... DUMMY
HT-H/W OPTIONS.
IO-ADDR.....
SC-SIG COND....
EL-LO EGU..... 0.00
EH-HI EGU..... 100.00
ET-EGU TAG..... PCT
OR-OUT REVERSE. N
CS-COLD START.. 0.00
DESC.... 1ST FULL
LL-LO OP LIMIT. 0.00
LH-HI OP LIMIT. 100.00
LR-RATE LIMIT.. 100.00
NX-NEXT BLK....
CP-COPY TO.....

TAG..... AOD-R3
DV-DEVICE..... DUMMY
HT-H/W OPTIONS.
IO-ADDR.....
SC-SIG COND....
EL-LO EGU..... 0.00
EH-HI EGU..... 100.00
ET-EGU TAG..... PCT
OR-OUT REVERSE. N
CS-COLD START.. 0.00
DESC.... 910405
LL-LO OP LIMIT. 0.00
LH-HI OP LIMIT. 100.00
LR-RATE LIMIT.. 100.00
NX-NEXT BLK....
CP-COPY TO.....

TAG..... AOD-TFF
DV-DEVICE..... DUMMY
HT-H/W OPTIONS.
IO-ADDR.....
SC-SIG COND....
EL-LO EGU..... 0.00
EH-HI EGU..... 100.00
ET-EGU TAG..... Kg
OR-OUT REVERSE. N
CS-COLD START.. 0.00
DESC.... dummy for total fresh feed fed to mill
LL-LO OP LIMIT. 0.00
LH-HI OP LIMIT. 100.00
LR-RATE LIMIT.. 100.00
NX-NEXT BLK....
CP-COPY TO.....

TAG..... AOD-BL
DV-DEVICE..... DUMMY
HT-H/W OPTIONS.
IO-ADDR.....
SC-SIG COND....
EL-LO EGU..... 0.00
EH-HI EGU..... 100.00
ET-EGU TAG..... Kg
OR-OUT REVERSE. N
CS-COLD START.. 29.60
DESC.... Dummy for reporting ball load used
LL-LO OP LIMIT. 0.00
LH-HI OP LIMIT. 100.00
LR-RATE LIMIT.. 100.00
NX-NEXT BLK....
CP-COPY TO.....

TAG..... AOD-WM
DV-DEVICE..... DUMMY
HT-H/W OPTIONS.
IO-ADDR.....
SC-SIG COND....
EL-LO EGU..... -279.45
EH-HI EGU..... 168.15
ET-EGU TAG..... PCT
OR-OUT REVERSE. N
CS-COLD START..
DESC....
LL-LO OP LIMIT. -279.45
LH-HI OP LIMIT. 168.15
LR-RATE LIMIT.. 447.60
NX-NEXT BLK....
CP-COPY TO..... AID-WM

TYPE: DI

TAG..... DIF-MM
DV-DEVICE..... OPT
HT-H/W OPTIONS.
IO-ADDR..... 1:41:6
CT-CLOSE TAG... RUNNING
OT-OPEN TAG.... STOPPED
ST-SCAN TIME... 10
IS-INIT SCAN... ON
II-INVERT..... N
DESC.... Mill motor contactor status(open/closed)
AT-ALM TYPE.... CLOSE
AD-ALM DEST.... HF
AP-ALM PRI..... H
AE-ALM ENABLE.. ENABLE
CC-ALM CONTACT.
CM-CC ALM MODE. ANY
NX-NEXT BLK....

TAG..... DIF-PM
DV-DEVICE..... OPT
HT-H/W OPTIONS.
IO-ADDR..... 1:41:5
CT-CLOSE TAG... RUNNING
OT-OPEN TAG.... STOPPED
ST-SCAN TIME... 10
IS-INIT SCAN... ON
II-INVERT..... N
DESC.... pump motor contactor status(open/closed)
AT-ALM TYPE.... CLOSE
AD-ALM DEST.... HF
AP-ALM PRI..... H
AE-ALM ENABLE.. ENABLE
CC-ALM CONTACT.
CM-CC ALM MODE. ANY
NX-NEXT BLK....

TAG..... DIF-SM
DV-DEVICE..... OPT
HT-H/W OPTIONS.
IO-ADDR..... 1:41:4
CT-CLOSE TAG... RUNNING
OT-OPEN TAG.... STOPPED
ST-SCAN TIME... 10
IS-INIT SCAN... ON
II-INVERT..... N
DESC.... screen motor contactor status (opn/clsd)
AT-ALM TYPE.... CLOSE
AD-ALM DEST.... HF
AP-ALM PRI..... L
AE-ALM ENABLE.. ENABLE
CC-ALM CONTACT.
CM-CC ALM MODE. ANY
NX-NEXT BLK....

TAG..... DIF-VF
DV-DEVICE..... OPT
HT-H/W OPTIONS.
IO-ADDR..... 1:41:0
CT-CLOSE TAG... RUNNING
OT-OPEN TAG.... STOPPED
ST-SCAN TIME... 10
IS-INIT SCAN... ON
II-INVERT..... N
DESC.... vib. feeder contactor status (opn/clsd)
AT-ALM TYPE.... NONE
AD-ALM DEST.... HF
AP-ALM PRI..... L
AE-ALM ENABLE.. ENABLE
CC-ALM CONTACT.
CM-CC ALM MODE. ANY
NX-NEXT BLK....

TYPE: DO

TAG..... DOF-MMR
DV-DEVICE..... OPT
HT-H/W OPTIONS.
IO-ADDR..... 1:41:9
CT-CLOSE TAG... RUNNING
OT-OPEN TAG.... STOPPED
CS-COLD START.. STOPPED
OI-INVERT..... N
DESC.... mill motor start - one shot on
NX-NEXT BLK....

TAG..... DOF-MMS
DV-DEVICE..... OPT
HT-H/W OPTIONS.
IO-ADDR..... 1:41:8
CT-CLOSE TAG... RUNNING
OT-OPEN TAG.... STOPPED
CS-COLD START.. RUNNING
OI-INVERT..... N
DESC.... mill motor stop - one shot off
NX-NEXT BLK....

TAG..... DOF-SM
DV-DEVICE..... OPT
HT-H/W OPTIONS.
IO-ADDR..... 1:41:11
CT-CLOSE TAG... ON
OT-OPEN TAG.... OFF
CS-COLD START.. OFF
OI-INVERT..... N
DESC.... screen motor contactor open/close
NX-NEXT BLK....

TAG..... DOF-PM
DV-DEVICE..... OPT
HT-H/W OPTIONS.
IO-ADDR..... 1:41:10
CT-CLOSE TAG... ON
OT-OPEN TAG.... OFF
CS-COLD START.. OFF
OI-INVERT..... N
DESC.... pump motor contactor open/close
NX-NEXT BLK....

TAG..... DOF-VF
DV-DEVICE..... OPT
HT-H/W OPTIONS.
IO-ADDR..... 1:41:15
CT-CLOSE TAG... ON
OT-OPEN TAG.... OFF
CS-COLD START.. OFF
OI-INVERT..... N
DESC.... vib. feeder contactor open/close
NX-NEXT BLK....

TAG..... DOF-FB
DV-DEVICE..... OPT
HT-H/W OPTIONS.
IO-ADDR..... 1:41:14
CT-CLOSE TAG... OPEN
OT-OPEN TAG.... CLOSE
CS-COLD START.. CLOSE
OI-INVERT..... N
DESC.... fresh feed bin door open/close
NX-NEXT BLK.... TR-DFB

TAG..... DOF-OG
DV-DEVICE..... OPT
HT-H/W OPTIONS.
IO-ADDR..... 1:41:12
CT-CLOSE TAG... CLOSE
OT-OPEN TAG.... OPEN
CS-COLD START.. OPEN
OI-INVERT..... N
DESC.... oversize sliding gate open/close
NX-NEXT BLK....

TAG..... DOF-OB
DV-DEVICE..... OPT
HT-H/W OPTIONS.
IO-ADDR..... 1:41:13
CT-CLOSE TAG... OPEN
OT-OPEN TAG.... CLOSE
CS-COLD START.. CLOSE
OI-INVERT..... N
DESC.... oversize bin door open/close
NX-NEXT BLK....

TAG..... DOF-DC
DV-DEVICE..... OPT
HT-H/W OPTIONS.
IO-ADDR..... 1:41:2
CT-CLOSE TAG... F I X
OT-OPEN TAG.... FISHER
CS-COLD START.. F I X
OI-INVERT..... N
DESC.... type of control FIX/FISHER
NX-NEXT BLK....

TAG..... DOD-FLAG
DV-DEVICE..... DUMMY
HT-H/W OPTIONS.
IO-ADDR..... 5:5
CT-CLOSE TAG... CLOSE
OT-OPEN TAG.... OPEN
CS-COLD START.. CLOSE
OI-INVERT..... N
DESC.... start stop weightometers
NX-NEXT BLK....

TAG..... DOD-FF-AL
DV-DEVICE..... DUMMY
HT-H/W OPTIONS.
IO-ADDR..... 0:0
CT-CLOSE TAG... CLOSE
OT-OPEN TAG.... OPEN
CS-COLD START.. OPEN
OI-INVERT..... N
DESC.... fresh feed alarm contact
NX-NEXT BLK....

TAG..... DOD-MSS
DV-DEVICE..... DUMMY
HT-H/W OPTIONS.
IO-ADDR..... 0:0
CT-CLOSE TAG... ON
OT-OPEN TAG.... OFF
CS-COLD START.. OFF
OI-INVERT..... N
DESC.... Mill Start/Stop switch
NX-NEXT BLK....

TYPE: PI

TAG..... PI-MW
EL-LO EGU..... 0.000
EH-HI EGU..... 0.900
ET-EGU TAG..... ipm
OEL-LO EGU OUT. 0.00
OEH-HI EGU OUT. 100.00
SL-SP LO CLAMP. 0.000
SH-SP HI CLAMP. 0.900
BM-BUMPLESS.... YES
OR-OUTPUT REV.. NO
DA-DEVIATION... 0.000
DB-DEAD BAND... 0.090
PB-PROP BAND... 300.00
RE-RESET(M/R).. 0.300
RA-RATE..... 0.000
NX-NEXT BLK.... SS-MW
CP-COPY TO.....

TAG..... PI-MS
EL-LO EGU..... 0.00
EH-HI EGU..... 107.41
ET-EGU TAG..... %CRT
OEL-LO EGU OUT. 0.00
OEH-HI EGU OUT. 100.00
SL-SP LO CLAMP. 0.00
SH-SP HI CLAMP. 107.41
BM-BUMPLESS.... YES
OR-OUTPUT REV.. NO
DA-DEVIATION... 0.00
DB-DEAD BAND... 11.11
PB-PROP BAND... 300.00
RE-RESET(M/R).. 0.400
RA-RATE..... 0.000
NX-NEXT BLK.... SS-MS
CP-COPY TO.....

TAG..... PI-LS
EL-LO EGU..... 0.0
EH-HI EGU..... 100.0
ET-EGU TAG..... %
OEL-LO EGU OUT. 0.0
OEH-HI EGU OUT. 110.0
SL-SP LO CLAMP. 0.0
SH-SP HI CLAMP. 100.0
BM-BUMPLESS.... YES
OR-OUTPUT REV.. NO
DA-DEVIATION... 0.0
DB-DEAD BAND... 10.0
PB-PROP BAND... 20.00
RE-RESET(M/R).. 2.000
RA-RATE..... 0.000
NX-NEXT BLK.... TR-SPSW
CP-COPY TO..... PI-SW

TAG..... PI-WM
EL-LO EGU..... -279.45
EH-HI EGU..... 168.15
ET-EGU TAG..... Kg
OEL-LO EGU OUT. 0
OEH-HI EGU OUT. 2000
SL-SP LO CLAMP. -279.45
SH-SP HI CLAMP. 168.15
BM-BUMPLESS.... YES
OR-OUTPUT REV.. NO
DA-DEVIATION... 0.00
DB-DEAD BAND... 0.00
PB-PROP BAND... 10.00
RE-RESET(M/R).. 0.000
RA-RATE..... 0.000
NX-NEXT BLK.... TR-OPIWM
CP-COPY TO.....

TAG..... PI-SW
EL-LO EGU..... 0.0
EH-HI EGU..... 110.0
ET-EGU TAG..... ipm
OEL-LO EGU OUT. 0.00
OEH-HI EGU OUT. 100.00
SL-SP LO CLAMP. 0.0
SH-SP HI CLAMP. 110.0
BM-BUMPLESS.... YES
OR-OUTPUT REV.. NO
DA-DEVIATION... 0.0
DB-DEAD BAND... 4.5
PB-PROP BAND... 330.00
RE-RESET(M/R).. 0.300
RA-RATE..... 0.000
NX-NEXT BLK.... SS-LSSW
CP-COPY TO.....

TYPE: LL
TYPE: DR
TYPE: RM
TYPE: TR

TAG..... TR-MW
EL-LO EGU..... 0.000
EH-HI EGU..... 0.900
ET-EGU TAG..... lpm
AT-AVG/COMPRESS.. 5
NX-NEXT BLK.... PI-MW

TAG..... TR-WM
EL-LO EGU..... -279.45
EH-HI EGU..... 168.15
ET-EGU TAG..... Kg
AT-AVG/COMPRESS.. 1
NX-NEXT BLK.... AOD-WM

TAG..... TR-MS
EL-LO EGU..... 0.00
EH-HI EGU..... 107.41
ET-EGU TAG..... %CRT
AT-AVG/COMPRESS.. 5
NX-NEXT BLK.... PI-MS

TAG..... TR-FB
EL-LO EGU..... -382.0
EH-HI EGU..... 518.0
ET-EGU TAG..... g
AT-AVG/COMPRESS.. 1
NX-NEXT BLK....

TAG..... TR-LS
EL-LO EGU..... 0.0
EH-HI EGU..... 100.0
ET-EGU TAG..... %
AT-AVG/COMPRESS.. 1
NX-NEXT BLK.... PI-LS

TAG..... TR-FF
EL-LO EGU..... 0
EH-HI EGU..... 2400
ET-EGU TAG..... gpm
AT-AVG/COMPRESS.. 5
NX-NEXT BLK.... CA-TF

TAG..... TR-SW
EL-LO EGU..... 0.0
EH-HI EGU..... 110.0
ET-EGU TAG..... lpm
AT-AVG/COMPRESS.. 5
NX-NEXT BLK.... PI-SW

TAG..... TR-OS
EL-LO EGU..... 0
EH-HI EGU..... 1000
ET-EGU TAG..... gpm
AT-AVG/COMPRESS.. 5
NX-NEXT BLK....

TAG..... TR-SF
EL-LO EGU..... 0.0
EH-HI EGU..... 110.0
ET-EGU TAG..... lpm
AT-AVG/COMPRESS.. 1
NX-NEXT BLK....

TAG..... TR-OB
EL-LO EGU..... -368.0
EH-HI EGU..... 357.0
ET-EGU TAG..... g
AT-AVG/COMPRESS.. 10
NX-NEXT BLK....

TAG..... TR-JM
EL-LO EGU..... 0.00
EH-HI EGU 500.00
ET-EGU TAG..... W
AT-AVG/COMPRESS.. 1
NX-NEXT BLK....

TAG..... TR-SPMS
EL-LO EGU..... 0.00
EH-HI EGU..... 107.41
ET-EGU TAG..... %CRT
AT-AVG/COMPRESS.. 5
NX-NEXT BLK.... SPO-MS

TAG..... TR-SPLS
EL-LO EGU..... 0.0
EH-HI EGU..... 100.0
ET-EGU TAG..... %
AT-AVG/COMPRESS.. 1
NX-NEXT BLK.... SPO-LS

TAG..... TR-SPMW
EL-LO EGU..... 0.000
EH-HI EGU..... 0.900
ET-EGU TAG..... lpm
AT-AVG/COMPRESS.. 5
NX-NEXT BLK.... SPF-MW

TAG..... TR-SPSW
EL-LO EGU..... 0.0
EH-HI EGU..... 110.0
ET-EGU TAG..... lpm
AT-AVG/COMPRESS.. 1
NX-NEXT BLK....

TAG..... TR-SPWM
EL-LO EGU..... -279.45
EH-HI EGU..... 168.15
ET-EGU TAG..... Kg
AT-AVG/COMPRESS.. 1
NX-NEXT BLK.... SPO-WM

TAG..... TR-OPIWM
EL-LO EGU..... 0
EH-HI EGU..... 2000
ET-EGU TAG..... gpm
AT-AVG/COMPRESS.. 1
NX-NEXT BLK....

TAG..... TR-DFB
EL-LO EGU..... 0.00
EH-HI EGU..... 100.00
ET-EGU TAG..... PCT
AT-AVG/COMPRESS.. 1
NX-NEXT BLK....

TYPE: RB

TAG..... SPF-MS
EL-LO EGU..... 0.00
EH-HI EGU..... 100.00
ET-EGU TAG..... %
R - RATIO..... 0.93
B - BIAS..... 0.00
NX-NEXT BLK....
CP-COPY TO.....

TAG..... RB-MS
EL-LO EGU..... 0.00
EH-HI EGU..... 107.41
ET-EGU TAG..... %CRT
R - RATIO..... 1.85
B - BIAS..... 0.00
NX-NEXT BLK.... TR-MS
CP-COPY TO..... AID-MSA

TYPE: DT
TYPE: SS

TAG..... SS-MW
EL-LO EGU..... 0.00
EH-HI EGU..... 100.00
ET-EGU TAG..... %
I2-INPUT 2.... AID-MW
I3-INPUT 3.... SPF-MW
I4-INPUT 4....
SM-SEL MODE... HI
NX-NEXT BLK.... AOF-MW

TAG..... SS-MS
EL-LO EGU..... 0.00
EH-HI EGU..... 100.00
ET-EGU TAG..... %
I2-INPUT 2.... SPF-MS
I3-INPUT 3....
I4-INPUT 4....
SM-SEL MODE... INPUT1
NX-NEXT BLK.... AOF-MS

TAG..... SS-LSSW
EL-LO EGU..... 0.00
EH-HI EGU..... 100.00
ET-EGU TAG..... %
I2-INPUT 2.... SP-LS
I3-INPUT 3....
I4-INPUT 4....
SM-SEL MODE... INPUT1
NX-NEXT BLK.... AOF-SW

TYPE: BB
TYPE: CA

TAG..... CA-TF
EL-LO EGU..... 0
EH-HI EGU..... 3400
ET-EGU TAG..... gpm
RN-ROUND ENAB.. Y
OUTPUT = (A+B)
B - INPUT 2.... AID-OS
C - INPUT 3.... 0.0000
D - INPUT 4.... 0.0000
E - INPUT 5.... 0.0000
F - INPUT 6.... 0.0000
G - INPUT 7.... 0.0000
H - INPUT 8.... 0.0000
NX-NEXT BLK.... CA-MW
CP-COPY TO.....

TAG..... CA-JM
EL-LO EGU..... 0.00
EH-HI EGU..... 500.00
ET-EGU TAG..... W
RN-ROUND ENAB.. Y
OUTPUT = ((((((A*B)*C)*D)*E)/F)-G)
B - INPUT 2.... AIF-MS
C - INPUT 3.... 2.0000
D - INPUT 4.... 3.1416
E - INPUT 5.... 9.8067
F - INPUT 6.... 60.000
G - INPUT 7.... AOD-JMZ
H - INPUT 8.... 0.0000
NX-NEXT BLK.... TR-JM
CP-COPY TO.....

TAG..... CA-MFILL1
EL-LO EGU..... -279.45
EH-HI EGU..... 168.15
ET-EGU TAG..... Kg
RN-ROUND ENAB.. Y
OUTPUT = (A-B)
B - INPUT 2.... 0.5000
C - INPUT 3.... 0.00
D - INPUT 4.... 0.00
E - INPUT 5.... 0.00
F - INPUT 6.... 0.00
G - INPUT 7.... 0.00
H - INPUT 8.... 0.00
NX-NEXT BLK.... CA-MFILL2
CP-COPY TO.....

TAG..... CA-MFILL2
EL-LO EGU..... -279.95
EH-HI EGU..... 167.65
ET-EGU TAG..... Kg
RN-ROUND ENAB.. Y
OUTPUT = (A-B)
B - INPUT 2.... 4.5000
C - INPUT 3.... 0.00
D - INPUT 4.... 0.00
E - INPUT 5.... 0.00
F - INPUT 6.... 0.00
G - INPUT 7.... 0.00
H - INPUT 8.... 0.00
NX-NEXT BLK....
CP-COPY TO.....

TAG..... CA-JMZ
EL-LO EGU..... 0.00
EH-HI EGU..... 300.00
ET-EGU TAG..... W
RN-ROUND ENAB.. Y
OUTPUT = B
B - INPUT 2.... CA-JM
C - INPUT 3.... 0.00
D - INPUT 4.... 0.00
E - INPUT 5.... 0.00
F - INPUT 6.... 0.00
G - INPUT 7.... 0.00
H - INPUT 8.... 0.00
NX-NEXT BLK.... AOD-JMZ
CP-COPY TO.....

TAG..... CA-MW
EL-LO EGU..... 0.000
EH-HI EGU..... 0.900
ET-EGU TAG..... lpm
RN-ROUND ENAB.. Y
OUTPUT = ((A/B)*C)
B - INPUT 2.... 1000.0
C - INPUT 3.... AID-WR
D - INPUT 4.... 0.0000
E - INPUT 5.... 0.0000
F - INPUT 6.... 0.0000
G - INPUT 7.... 0.0000
H - INPUT 8.... 0.0000
NX-NEXT BLK.... TR-SPMW
CP-COPY TO..... PI-MW

TAG..... SPF-MW
EL-LO EGU..... 0.00
EH-HI EGU..... 100.00
ET-EGU TAG..... %
RN-ROUND ENAB.. Y
OUTPUT = (A*B)
B - INPUT 2.... 111.11
C - INPUT 3.... 0.00
D - INPUT 4.... 0.00
E - INPUT 5.... 0.00
F - INPUT 6.... 0.00
G - INPUT 7.... 0.00
H - INPUT 8.... 0.00
NX-NEXT BLK....
CP-COPY TO.....

TYPE: DC
TYPE: CV
TYPE: RV
TYPE: BL
TYPE: SD
TYPE: SC
TYPE: TT
TYPE: PG

```
TAG..... PG-MSS
AD-ALM DEST.... HF
AP-ALM PRI..... L
ST-SCAN TIME... 5
IS-INIT SCAN... ON
IA-INIT A/M.... AUTO
DESC.... mill start/stop switch position
00 IF      DOD-MSS  = OFF  GOTO 4
01 CLOSE   DOF-MMR
02 DELAY   10
03 OPEN    DOF-MMR
04 IF      DOD-MSS  = OFF  GOTO 6
05 GOTO    4
06 OPEN    DOF-MMS
07 DELAY   10
08 CLOSE   DOF-MMS
09 IF      DOD-MSS  = ON   GOTO 0
10 GOTO    9
11 NUL
12 NUL
13 NUL
14 NUL
15 NUL
16 NUL
17 NUL
18 NUL
19 NUL
```

```
TAG..... PG-SFILL
AD-ALM DEST.... HF
AP-ALM PRI..... L
ST-SCAN TIME... 5
IS-INIT SCAN... OFF
IA-INIT A/M.... AUTO
DESC.... fill up pump box and start pump
00 SETLIM      5.00
01 SETOUT   PI-SW     90.00
02 DELAY    100
03 IF       AIF-SW  =   0.0 GOTO 11
04 WAITFOR  AIF-LS  >= SP-LS
05 CLOSE    DOF-PM
06 DELAY    10
07 IF       DIF-PM  = STOPPED GOTO 15
08 SETAUTO  PI-SW
09 SETAUTO  PI-LS
10 END
11 SETERROR
12 MSG      No water-check water/air supply
13 DELAY    300
14 GOTO     3
15 SETERROR
16 SETOUT   PI-SW     0.00
17 MSG      Pump not running-check switch
18 DELAY    300
19 GOTO     7
```

```
TAG..... PG-MFILL
AD-ALM DEST.... HF
AP-ALM PRI..... L
ST-SCAN TIME... 5
IS-INIT SCAN... OFF
IA-INIT A/M.... AUTO
DESC.... Mill fill up
00  SETLIM      5.00
01  CLOSE   DOD-FLAG
02  SETOUT   PI-WM      2000
03  WAITFOR  AIF-WM  >= CA-MFILL2
04  SETOUT   PI-WM      1000
05  WAITFOR  AIF-WM  >= CA-MFILL1
06  NUL
07  NUL
08  SETAUTO  PI-WM
09  SETAUTO  PI-MW
10  END
11  NUL
12  NUL
13  NUL
14  NUL
15  NUL
16  NUL
17  NUL
18  NUL
19  NUL
```

```
TAG..... PG-MW
AD-ALM DEST.... HF
AP-ALM PRI..... L
ST-SCAN TIME... 5
IS-INIT SCAN... OFF
IA-INIT A/M.... AUTO
DESC.... mill water startup
00  SETLIM      5.00
01  SETOUT   PI-MW      80.00
02  DELAY    100
03  IF       AIF-MW  =  0.000 GOTO 7
04  SETOUT   AID-MW     20.00
05  NUL
06  END
07  SETERROR
08  MSG      No water-check water/air supply
09  DELAY    300
10  GOTO     3
11  NUL
12  NUL
13  NUL
14  NUL
15  NUL
16  NUL
17  NUL
18  NUL
19  NUL
```

```
TAG..... PG-MSTART
AD-ALM DEST.... HF
AP-ALM PRI..... L
ST-SCAN TIME... 5
IS-INIT SCAN... OFF
IA-INIT A/M.... AUTO
DESC.... start up mill
00  SETLIM      5.00
01  CLOSE   DOD-MSS
02  SETOUT   PI-MS      20.00
03  DELAY    100
04  IF       AIF-MS  =   0.0 GOTO 16
05  SETAUTO  PI-MS
06  WAITFOR  RB-MS   >= SP-MS
07  DELAY    3000
08  RUN      AID-JMZ
09  DELAY    10
10  STOP     AID-JMZ
11  DELAY    10
12  SETERROR
13  MSG      PUT BALL CHARGE INTO MILL
14  DELAY    1800
15  END
16  SETERROR
17  MSG      Mill not started-check swiches
18  DELAY    300
19  GOTO     4
```

```
TAG..... PG-SCREEN
AD-ALM DEST.... HF
AP-ALM PRI..... L
ST-SCAN TIME... 5
IS-INIT SCAN... OFF
IA-INIT A/M.... AUTO
DESC.... screen motor startup
00  CLOSE    DOF-SM
01  DELAY    20
02  IF       DIF-SM  = STOPPED GOTO 4
03  END
04  SETERROR
05  MSG      Screen not running-check swich
06  DELAY    300
07  GOTO     2
08  NUL
09  NUL
10  NUL
11  NUL
12  NUL
13  NUL
14  NUL
15  NUL
16  NUL
17  NUL
18  NUL
19  NUL
```

```
TAG..... PG-START
AD-ALM DEST.... HF
AP-ALM PRI..... L
ST-SCAN TIME... 5
IS-INIT SCAN... OFF
IA-INIT A/M.... AUTO
DESC.... Circuit startup sequence
00  NUL
01  NUL
02  NUL
03  NUL
04  CALL    PG-SCREEN
05  CALL    PG-SFILL
06  CALL    PG-MSTART
07  SETERROR
08  MSG
09  CALL    PG-MW
10  CALL    PG-MFILL
11  SETERROR
12  MSG     STARTUP COMPLETE
13  DELAY   100
14  MSG
15  RUN     PG-PIOG
16  END
17  NUL
18  NUL
19  NUL
```

```
TAG..... PG-INIT
AD-ALM DEST.... HF
AP-ALM PRI..... L
ST-SCAN TIME... 5
IS-INIT SCAN... ON
IA-INIT A/M.... AUTO
DESC.... Initialize system
00  RUN     AIF-MS
01  SETMAN  PI-MS
02  SETOUT  PI-MS     0.00
03  RUN     SP-MS
04  OPEN    DOD-MSS
05  RUN     PG-MSS
06  RUN     AIF-OM
07  OPEN    DOF-MMR
08  CLOSE   DOF-MMS
09  NUL
10  RUN     AIF-MW
11  SETMAN  PI-MW
12  SETOUT  PI-MW     0.00
13  RUN     AID-FF
14  END
15  NUL
16  NUL
17  NUL
18  NUL
19  NUL
```

```
TAG..... PG-INIT2
AD-ALM DEST.... HF
AP-ALM PRI..... L
ST-SCAN TIME... 5
IS-INIT SCAN... ON
IA-INIT A/M.... AUTO
DESC.... Initialize system
00  RUN     AIF-LS
01  SETMAN  PI-LS
02  SETOUT  PI-LS     0.0
03  RUN     SP-LS
04  RUN     AIF-SW
05  SETMAN  PI-SW
06  SETOUT  PI-SW     0.00
07  NUL
08  RUN     DIF-SM
09  OPEN    DOF-SM
10  NUL
11  RUN     DIF-PM
12  OPEN    DOF-PM
13  NUL
14  CLOSE   DOF-DC
15  NUL
16  RUN     AIF-SF
17  END
18  NUL
19  NUL
```

```
TAG..... PG-INIT3
AD-ALM DEST.... HF
AP-ALM PRI..... L
ST-SCAN TIME... 5
IS-INIT SCAN... ON
IA-INIT A/M.... AUTO
DESC.... Initialize system
00  RUN     AIF-WM
01  SETMAN  PI-WM
02  SETOUT  PI-WM     0
03  RUN     SP-WM
04  CLOSE   DOD-FLAG
05  OPEN    DOD-FF-AL
06  RUN     AIF-FB
07  RUN     DIF-VF
08  RUN     AIF-OB
09  RUN     AID-OS
10  OPEN    DOF-VF
11  OPEN    DOF-FB
12  OPEN    DOF-OO
13  OPEN    DOF-OB
14  STOP    AID-JMZ
15  SETSEL  SS-MS     INPUT1
16  SETSEL  SS-MW     HI
17  SETSEL  SS-LSSW   INPUT1
18  SETOUT  AOD-TFF   0.00
19  END
```

TAG..... PG-DEF
AD-ALM DEST.... HF
AP-ALM PRI..... L
ST-SCAN TIME... 5
IS-INIT SCAN... ON
IA-INIT A/M.... AUTO
DESC.... Default values for setpoints etc
00 SETOUT SP-MS 60.00
01 SETOUT SP-LS 30.0
02 SETOUT SP-WM 40.00
03 SETOUT AID-FF 0
04 SETOUT AID-OS 0
05 SETOUT AID-JMZ 0.00
06 SETOUT AOD-TFF 0.00
07 SETOUT AOD-BL 29.60
08 SETOUT AID-WR 0.600
09 NUL
10 END
11 NUL
12 NUL
13 NUL
14 NUL
15 NUL
16 NUL
17 NUL
18 NUL
19 NUL

TAG..... PG-STOP
AD-ALM DEST.... HF
AP-ALM PRI..... L
ST-SCAN TIME... 5
IS-INIT SCAN... OFF
IA-INIT A/M.... AUTO
DESC.... Circuit shutdown sequence
00 SETOUT AID-MW 0.00
01 STOP PG-PIOG
02 CALL PG-STOP1
03 OPEN DOD-MSS
04 OPEN DOF-VF
05 SETMAN PI-WM
06 SETOUT PI-WM 0
07 SETMAN PI-MW
08 SETOUT PI-MW 6.00
09 SETMAN PI-SW
10 SETOUT PI-SW 0.00
11 SETLIM 5.00
12 WAITFOR AIF-LS = 10.0
13 DELAY 50
14 OPEN DOF-PM
15 CALL PG-INIT
16 CALL PG-INIT2
17 CALL PG-INIT3
18 NUL
19 END

TAG..... PG-STOP1
AD-ALM DEST.... HF
AP-ALM PRI..... L
ST-SCAN TIME... 5
IS-INIT SCAN... OFF
IA-INIT A/M.... AUTO
DESC.... stops all programs used in startup
00 STOP PG-START
01 STOP PG-SFILL
02 STOP PG-MFILL
03 STOP PG-MSTART
04 STOP PG-MW
05 STOP PG-SCREEN
06 END
07 NUL
08 NUL
09 NUL
10 NUL
11 NUL
12 NUL
13 NUL
14 NUL
15 NUL
16 NUL
17 NUL
18 NUL
19 NUL

TAG..... PG-FISH
AD-ALM DEST.... HF
AP-ALM PRI..... L
ST-SCAN TIME... 5
IS-INIT SCAN... ON
IA-INIT A/M.... AUTO
DESC.... handles change of control, FIX/FISHER
00 IF DOF-DC = FISHER GOTO 2
01 GOTO 0
02 SETSEL SS-MS INPUT2
03 SETSEL SS-MW INPUT3
04 SETSEL SS-LSSW INPUT2
05 IF DOF-DC != FISHER GOTO 7
06 GOTO 5
07 SETSEL SS-MS INPUT1
08 SETSEL SS-MW HI
09 SETSEL SS-LSSW INPUT1
10 GOTO 0
11 NUL
12 NUL
13 NUL
14 NUL
15 NUL
16 NUL
17 NUL
18 NUL
19 NUL

TAG..... PG-PJOG
AD-ALM DEST.... HF
AP-ALM PRI..... L
ST-SCAN TIME... 255
IS-INIT SCAN... OFF
IA-INIT A/M.... AUTO
DESC.... jogs pump if screen feed flow < 50 lpm
00 IF AIF-SF < 80.7 GOTO 2
01 GOTO 0
02 OPEN DOF-PM
03 DELAY 100
04 CLOSE DOF-PM
05 DELAY 100
06 GOTO 0
07 NUL
08 NUL
09 NUL
10 NUL
11 NUL
12 NUL
13 NUL
14 NUL
15 NUL
16 NUL
17 NUL
18 NUL
19 NUL

Table F2. 60cm SAG Mill Equipment Tag Name List
(excluding Software Tag Names)

Tag Name	Name	Comments
AF	Air Filter, Supply	air supply is 80psig
AI-FB	Analog Input, Fresh Feed Bin Weight	4-20mA signal from WT-FB, to IO PAK module
AI-LS	Analog Input, Level of the Sump	4-20mA signal from LT-S, to IO PAK module
AI-MW	Mill Water Analog Input	4-20mA signal from FT-MW, to IO PAK module
AI-OB	Analog Input, Screen Oversize Bin Weight	4-20mA signal from WT-OB, to IO PAK module
AI-OM	Analog Input, Torque of mill	4-20mA signal from OT-M, to IO PAK module
AI-SF	Analog Input, Screen Feed	4-20mA signal from FT-SF, to IO PAK module
AI-SW	Analog Input, Sump Water	4-20mA signal from FT-SW, to IO PAK module
AI-WM	Analog Input, Weight of the Mill	4-20mA signal from WT-M, to IO PAK module
AO-MS	Analog Output, Mill Speed Setpoint	4-20mA signal, from I/O Pak Module to SIC-M (set point)
AO-MSA	Analog Output, Mill Speed	4-20mA signal, from I/O Pak Module to SIC-M (process variable)
AO-MW	Analog Output, Mill Water Setpoint	4-20mA signal, from I/O Pak Module to FIC-MW (set point)
AO-SW	Analog Output, Sump Water Setpoint	4-20mA signal, from I/O Pak Module to FIC-SW (set point)
AR-20	Air Regulator, I/P converters	20 PSIG output, for FY-MW and FY-SW
AR-40	Air Regulator, Solenoids	40 PSIG output, for FCS-FB, FCS-OB, and FCS-OG
CB-110	110 VAC Power Source	single pole circuit breaker, for TB-S1 (H) in the Sensor and Signal Panel Box
CB-208	208 VAC Power Source	triple pole circuit breaker, all power except CB-110
CB-PM	Circuit Breaker, Pump Motor	single pole circuit breaker (208 VAC), local on/off switch for pump motor
CT-PM	Contactor (Starter), Pump Motor	has overload protection
CT-SM	Contactor, Screen Motor	
CT-VF	Contactor, Feeder Vibrator	

Tag Name	Name	Comments
DI-MM	Digital Input, Mill Motor	detects when the mill motor has been switched on/off
DI-PM	Digital Input, Pump Motor	detects when the pump motor has been switched on/off
DI-SM	Digital Input, Screen Motor	detects when the screen motor has been switched on/off
DI-VF	Digital Input, Vibrating Feeder	detects when the vibrating feeder has been switched on/off
DO-DC	Digital Output, Digital Control On/Off	switches between the Fisher™ single loop controllers and the FIX ACE™ control
DO-FB	Digital Output, Fresh Feed Bin	actuates the fresh feed bin solenoid
DO-MMR	Digital Output, Mill Motor Run	starts the mill motor
DO-MMS	Digital Output, Mill Motor Stop	stops the mill motor
DO-OB	Digital Output, Oversize Bin	actuates the oversize bin solenoid
DO-OG	Digital Output, Oversize Gate	actuates the oversize sliding gate solenoid
DO-PM	Digital Output, Pump Motor	starts/stops the pump motor
DO-SM	Digital Output, Screen Motor	starts/stops the screen motor
DO-VF	Digital Output, Vibrating Feeder	starts/stops the vibrating feeder
FCP-FB	Flow Control Piston, Fresh Feed Bin Door	opens/closes the fresh feed bin door
FCP-OB	Flow Control Piston, Oversize Bin Door	opens/closes the oversize bin door
FCP-OG	Flow Control Piston, Oversize Gate	opens/closes the oversize sliding gate
FCS-FB	Flow Control Solenoid, Fresh Feed Bin Door	24VDC, actuates the oversize sliding gate piston
FCS-OB	Flow Control Solenoid, Oversize Bin Door	24VDC, actuates the oversize bin door piston
FCS-OG	Flow Control Solenoid, Oversize Gate	24VDC, actuates the oversize sliding gate piston
FCV-MW	Flow Control Valve, Mill Water	1/4" A/O valve
FCV-SW	Flow Control Valve, Sump Water	1" A/O valve
FE-SF	Flow Sensor, Screen Feed	Foxboro™ magnetic flow meter
FI-SF	Flow Indicator, Screen Feed	
FIC-MW	Flow Indicating Controller, Mill Water	Fisher™ DPR900 single loop controller

Tag Name	Name	Comments
FIC-SW	Flow Indicating Controller, Sump Water	Fisher™ DPR900 single loop controller
FT-MW	Flow Transmitter, Mill Water	Foxboro™ differential pressure meter
FT-SF	Flow Transmitter, Screen Feed (Sump Discharge)	Foxboro™ magnetic flow meter
FT-SW	Flow Transmitter, Sump Water	Foxboro differential pressure meter
FY-MW	Current to Air Converter, Mill Water	converts a 4-20 mA input signal to a 3-15psig output signal
FY-SW	Current to Air Converter, Sump Water	converts a 4-20 mA input signal to a 3-15psig output signal
IO-AN	Input/output Device, Analog signals	Action IO PAK™, analog signals from and to the circuit
IO-DI	Input/output Device, Analog signals	Action IO PAK™, digital signals from and to the circuit
IFX-MS	Frequency Input, Mill Speed	signal from mill speed sensor
JBI-110	Junction Box #1, 110VAC	power for field mounted sensors, 110VAC
LIC-S	Level Indicating Controller, Sump	Fisher™ DPR900 single loop controller
LT-S	Level Transmitter, Sump	capacitance probe
MM	Mill Motor	3 HP DC, variable speed
OE-M	Torque Sensor, Mill	wheatstone bridge
OT-M	Torque Transmitter, Mill	Action Pak™ 4061
PM	Pump Motor	3HP AC single phase, 208VAC
PS-06	6 VDC Power Supply	from Radio Shack
PS-24	24 VDC Power Supply	
SE-M	Speed Sensor, Mill	Ametek Power Instruments, Model 1020 Encoder
SIC-M	Speed Indicating Controller, Mill	Fisher™ DPR900 single loop controller
SM	Screen Motor	1/4 HP AC single phase, 110VAC
SW-CT	Contactors On/Off Switches	
SW-SM	Switch, Screen Motor	local on/off switch
SZ-MM	Speed Actuator, Mill Motor	Reliance™
TB-P1	Terminal Block, Power Panel Box #1	
TB-P2	Terminal Block, Power Panel Box #2	

Tag Name	Name	Comments
TB-P3	Terminal Block, Power Panel Box #3	
TB-P4	Terminal Block, Power Panel Box #4	
TB-S1	Terminal Block, Signal Panel box #1	
TB-S2	Terminal Block, Signal Panel box #2	
TB-S3	Terminal Block, Signal Panel box #3	
VZ-F	Vibrator Actuator, Fresh Feed	ERIZ™ magnetic vibrating feeder
WE-FB	Weight Sensor, Fresh Feed Bin	wheatstone bridge, load cell
WE-M	Weight Sensor, Mill	wheatstone bridge, load beam
WE-OB	Weight Sensor, Oversize Bin	wheatstone bridge, load cell
WT-FB	Weight Transmitter, Fresh Feed Bin	Action Pak™ 4051
WT-M	Mill Weight Transmitter	Action Pak™ 4051
WT-OB	Oversize Bin Weight Transmitter	Action Pak™ 4051

Appendix G:
Software and Equipment List(s)

Introduction:

The following equipment lists are for the 60 cm semiautogenous grinding (SAG) circuit at the University of British Columbia (UBC). Most or all of the equipment is commercially available and is used in accordance with current industrial practice. The lists include, a brief description, and supplier names and addresses. Minor items, such as plumbing fittings, are not included in the lists.

Software:

Table G1. Software for the 60cm Semiautogenous Grinding (SAG) mill at the University of British Columbia (UBC).

Item	Supplier	Notes
C Compiler Microsoft C Version 6.0	UBC Bookstore Vancouver, B.C. (604)228-4748	used to write 'special applications' that interface with the FIX control software
Computer Control Software Installation FIX ACE Version 3.0	CB Engineering North Vancouver, B.C. (604)980-8505	HALOIBME.DEV and HALOIBM.DEV in v3.0 must be replaced with HALOIBME.DEV and HALOIBM.DEV from v2.33, so the v 2.33 displays work properly

Major Equipment:

Major equipment includes most of the large and expensive items in the circuit.

Table G2. Action I/O Pak Material List for 60cm SAG Mill at the University of British Columbia.

Item	Qty	Unit	Model No.	Description
1	2	ea	AICP-IOPAK	Basic Unit
2	1	ea	AICP-IFX-01	0-20000z freq. input
3	8	ea	AICP-I4420	4-20mADC input
4	4	ea	AICP-O4420	4-20mADC output
5	2	ea	AICP-IAC5-19	AC input 120VDC
6	1	ea	AICP-IAC5A-19	AC input 240VDC
7	3	ea	AICP-OA5-19	AC output 120VAC
8	1	ea	AICP-IDC5-19	DC input 3.3 to 32VDC
9	6	ea	AICP-ODC5-19	DC output 3 to 60VDC

Table G3. Major Equipment for the 60cm Semiautogenous Grinding (SAG) mill at the University of British Columbia (UBC).

Item	Supplier	Notes
60cm Mill Motor Reducxion Gear	Boxxon Gear	Cat No. F332-30-G1 Control No. 9-58902-46 Model No. 003 Max Class 1 Service Input RPM 1750 Input HP 3,000 Output Torque 2625 lbsin ("300 Series" on sticker on top)
60cm SAG Mill	Dominion Engineering	60cm diameter, 25cm long, 1cm slot discharge, wet mill
60cm Sag Mill Motor variable speed DC electric motor	Boxxon Gear Inxcon International Inc. 14 Hayward Street Quincy, Massachusetts 02171 USA	Cat No. PM 18300TP-1 Item No. 63214 HP 3 FLA 15.1 P.F. 1.35 RPM 1750 FLD P.M. INS FENCL TEFC Serv Fact 1 ARM V 180 Ser 16
Computer Input/Output* Acxion I/O PAK* Two (2) are Needed, One for Digital, One for Analog Acxion I/O Pak Modules*	Thos. W. Makay & Son Ltd. Joe Turin 1807 Fir St. Vancouver, B.C. V6J 3A9 (604)731-6561	power is 110VAC, modules for input and output signals, uses RS232C protocol to and from computer
Industrial Computer Acxion BC 20 Industrial AT 286 Computer	Thos. W. Makay & Son Ltd. Joe Turin 1807 Fir St. Vancouver, B.C. V6J 3A9 (604)731-6561	30MB HD 3.5" 720K DD 5.25" 1.2M DD ARTIC card w/ 512K memory an AT 386 computer is recommended
Mezzanine Platform Redirack Platform and Planking	Pacific Warehouse Equipmens Ltd. Ed Adler #4-109 Brand St. New West., B.C. V3L 5H4 (604)524-8961	4-vert frame 24"x8y" 4-HD fy beam 110"x6" open steel planking, slip resistant
Pump Box Sheet Steel, Urethane Lined	Custom Welding Shop or your own Facilities	sloped bottom, 3.75cm discharge

Table G3. Major Equipment for the 60cm Semiautogenous Grinding (SAG) mill at the University of British Columbia (UBC) (cont).

Item	Supplier	Notes
Pump Motor 3hp 208VAC, single phase	Reliance Electric Co. Cleveland, Ohio 44117 U.S.A.	Duty Master A.C. Motor ID No. C18G102E By Frame 184T Type CS Ins. Class BHP 3 RPM 1730 Volts 115/230 AMPS 35/17.5 HZ 60 SF 1.0
Variable Speed Centrifugal Pump Galigher Co. Model: Vacseal Pump D15VRC100 Variable Dia. Pulley	Galigher Ash Ltd. Terry Vancouver, B.C. (604)941-3373	21.5cm pump, 3.75cm discharge, 3.75cm inlet, 90+ipm flow rate Serial No. P737010 VR-A-101
Vibrating Feeder Eriez Magnetics Model: FBV-413	P. J. Honey Ken Honeyman Burnaby, B.C. (604)430-1531 Headquarters: Eriez Manufacturing Company Erie, Pennsylvania U.S.A.	stores and feeds fresh feed to the SAG mill, -30mm feed Hi-Vi Volumetric Feeder FBV 413 Style 26 Serial No. 198 Volts 115 CY 60 AMPS 3.1
Vibrating Screen Universal Vibrating Screen Company Model: Uniflex S-1514	Burnaby Machine & Mill Equipment Ltd. Colin Alexander (604)888-8400 Universal Vibrating Screen Company Racine, Wisconsin U.S.A.	6.25mm square mesh inclined at 25°, uses 1/4hp single phase motor Vibrating Screen Uniflex S-1514 Part S-104666-03 Motor: Gould Century Motor Gould Inc. Electric Motor Div. St. Louis, Missouri 63166 U.S.A. Frame 56 Type SP HP 1/4Code P Hertz 60PH1 RPM 1725 Volts 115 Enc. TE AMPS 3.8 Time Cont Ambient 40DC SF 1.00 Form K8E Ins Class A Cat No. F661 Serial Y8

* see Table G2 for modules materials list on page G2.

Sensors:

Table G4. Sensor, Actuator, and Ancillary Equipment for the 60cm Semiautogenous Grinding (SAG) mill at the University of British Columbia (UBC).

Item	Supplier	Notes
09VDC Power Supply	Radio Shack	110VAC input 9VDC output
24VDC power Supply Hammond 24VDC Power Supply Model No. G60DF 1-24	Gough Electric Berne Vancouver, B.C. (604)438-8661	110VAC input 24VDC, 1.8A output add a small fuse to the 110VAC power input to protect it
Air Filter filter for control valve and solenoid air		my best guess from talking to several suppliers
Air Valve Regulator	Foxboro Canada Inc. Lawrence 100C-4185 Still Cr Dr Burnaby, B.C. (604)293-1631	45psig output air for fresh feed and oversize solenoids
Bridge Input Signal Conditioner Acuon PAK Model No. 4051 four are used	Thos. W. Makay & Son Ltd. Joe Turin 1807 Fir St. Vancouver, B.C. V6J 3A9 (604)731-6561	supplies power to load cells and converts load cell output to 4-20mA signal 110VAC input 4-20mA output 4ea are used
Control Valve Air Regulator	Foxboro Canada Inc. Lawrence 100C-4185 Still Cr Dr Burnaby, B.C. (604)293-1631	30psig output air for the water control valves
Fresh Feed Feeder Assembly Custom Made at UBC	UBC-MMPE Kurt Lund 6350 Stores Rd. Rm 517D Vancouver, B.C. V6T 1W5 (604)228-6217	accurate low capacity feeder for SAG mill feed
Mill Motor Speed Follower Boston Gear Option 25B Item Code: 67487	Western Eq Ltd Rob Hopkins 13480 Verdun Pl Richmond, B.C. V8V 1V2 (604)278-9581	card for computer control of mill speed, get it unless you ordered Option 25B w/ your Rationrol controller
Mill Motor Start/Stop, Speed Control Rationrol	Incom International Burnaby, B.C. V5C 3E (604) 298-6212 Boston Gear Enterprises Ltd	

Table G4. Sensor, Actuator, and Ancillary Equipment for the 68cm Semiautogenous Grinding(SAG) mill at the University of British Columbia (UBC) (cont).

Item	Supplier	Notes
Mill Speed Sensor Ametek Encoder Model No. 1020 Plastic Encoding Disk Custom Machined to Fit Mill Shaft in your machine shop	Brian Conrols Roy Bentsons Vancouver, B.C. (604)421-2341	interupter module uses an infared emissing diode, a disk w/ slots, and a silicon photoresistor plastic disk w/ 60 or 120 slots to interrupt the light emitted from the diode
Mill Torque Sensor	Shimkok	No. 94061 Type TM/30A 30Kg-m capacity Made in Japan Date: October 1969
Mill Water Control Valve Badger Meter, Inc Research 1/4" Control Valve Model No. 75	Northern Columbia Process Eq. 1234 Marine Dr North Vancouver, B.C. V6P 1T2 (604)987-7194	diaphragm control valve, air to open, 3-15psig Mod 75 Trim K Serial No. 119417
Mill Water Control Valve Signal Current to Air Converter Foxboro I/P Converter Model No. E69F-B12	Foxboro Canada Inc. Lawrence 100C-4185 Still Cr Dr Burnaby, B.C. (604)293-1631	Model 696A -2I01 Serial M-230164 C input 4-20 MA output 3-15psig Supply 19-23 PSI Max OHMS 660 Cert Spec. CS-E/CN-A Ref No. M-404139 B Origin 2648152
Mill Water Flow Sensor Foxboro Differential Pressure Cell	Foxboro Canada Inc. Lawrence 100C-4185 Still Cr Dr Burnaby, B.C. (604)293-1631	Model E13 DM-IKAM2 Serial M-177528 Output 4-20 mA Supply 15-50 VDC Capsul 316 SS Body Sust Range Limits - 205 a 205 H2i
Mill Weight Sensor BLH Electronics Load Beam Model No. LBP1 500lb Capacity	BLH Electronics 75 Shawmut Rd. Canton, MA 02021-9111 (617)821-2000	deflection of the load beam element determines the mill weight

Table G4. Sensor, Actuator, and Ancillary Equipment for the 60cm Semiautogenous Grinding(SAG) mill at the University of British Columbia (UBC) (cont).

Item	Supplier	Notes
Oversize Flow Meter Custom Made at UBC	UBC-MMPE Kurt Lund 6350 Stores Rd. Rm 517D Vancouver, B.C. V6T 1W5 (604)228-6217	accurate low capacity feeder for screen oversize
Pump Motor Starter Square D Motor Starter Model No. 8536 SBE-1	E.B. Horseman Surrey, B.C. (604)597-5796	motor starter, actuated by 110VAC signal controlled by the computer
Screen Feed Flow Sensor Foxboro Magnetic Flow Sensor and Transmitter Model No. Sensor 2811-SABA-T5G-G Transmitter E96P-1A	Foxboro Canada Inc. Lawrence 100C-4185 Still Cr Dr Burnaby, B.C. (604)293-1631	110VAC power 4-20mA output redundant signal for data adjustment Size 1.5 in Tube 304SS Style A Liner Teflon Electrodes 316SS
Sump Level Sensor Great Lakes Capacitance Level Sensor Model No. sensor 690L probe 40	Pyramid Mean. & Controls Walter Volberg Vancouver, B.C. (604)594-9191	110VAC input 4-20mA output you need to make a simple mount to support the probe
Sump Water Control Valve Signal Current to Air Converter Foxboro I/P Converter Model No. E69P-B12	Foxboro Canada Inc. Lawrence 100C-4185 Still Cr Dr Burnaby, B.C. (604)293-1631	4-20mA input 3-15PSIG output
Sump Water Flow Control Valve Robertshaw 1" Control Valve Model No. VC 210-BL-ATO-B2	Pyramid Measurement & Controls Ltd. Walter Volberg #205-13395 76th Av Surrey, B.C. V3W 2V8 (604)594-9191	diaphragm control valve, air to open, 3-15psig
Sump Water Flow Sensor Foxboro Differential Pressure Cell and Orifice Plate Cell: Model No. 843DP-H-2115K	Foxboro Canada Inc. Lawrence 100C-4185 Still Cr Dr Burnaby, B.C. (604)293-1631	Model E13 DM-IKAM2 Serial M-377529 Output 4-20 mA Supply 15-50 VDC Capsul 316 SS Body Sanst Range Limits - 205 + 205 H2)

Table G4. Sensor, Actuator, and Ancillary Equipment for the 60cm Semiautogenous Grinding(SAG) mill at the University of British Columbia (UBC) (cont).

Item	Supplier	Notes
Vibrating Feeder Contactor Potter Brumfield Contactor Model No. PRD7AYO	Gough Electric Bernie Vancouver, B.C. (604)438-8661	vibrating feeder contactor, actuated by 110VAC signal controlled by the computer
Vibrating Screen Motor Contactor spreher+schuh Contactor Model No. CA3-9-10-120-GO	Beaver Electric Machinery Ltd. Dave Nosella Burnaby, B.C. (604)438-5201	motor contactor, actuated by 110VAC signal controlled by the computer

I. Miscellaneous Electrical, Plumbing, and Air:

Table G5. Miscellaneous Electrical, Plumbing, and Air Equipment for the 60cm Semiautogenous Grinding (SAG) mill at the University of British Columbia (UBC).

Item	Supplier	Notes
Cable Tray Panduit 2"x2"-6'	Ecol Electric Ltd Vancouver, B.C. (604)294-5141	20 pieces, or 120'
Circuit Breakers Square D Model No. QUO 330 and QUO 115	Gough Electric Bernie Vancouver, B.C. (604)438-8661	1-208 VAC, 3 pole 1 110VAC, 1 pole
Panel Boxes Hammond General Purpose Enclosure Model No. 141836	Gough Electric Bernie Vancouver, B.C. (604)438-8661	3 - 24"x24" panel boxes misc nipples, lock nuts, etc
Plumbing		20'-1/2" pvc pipe 42'-1-1/4" pvc pipe misc nipples, unions, elbows, etc
Wire, etc power and signal wire, fuses, labels, air tubing, fixings, etc	ITT RAE Vancouver, B.C. (604)293-5103	shielded wire for signals rubber coated for power to the panel boxes 14,18, and 22Ga wire for power cabling misc connectors and wire

Appendix H:
Database, Links, Report Format, etc.
(Disketts)

Important

The password for the Trend and tuning Displays is **tune** this is the only place the password is listed. If you have any problems using the password use the help (<F1> key) or the FIX™ manual stored under the computer monitor at the SAG mill.

Important